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Rock Excavation in Deep Pit by Dragline

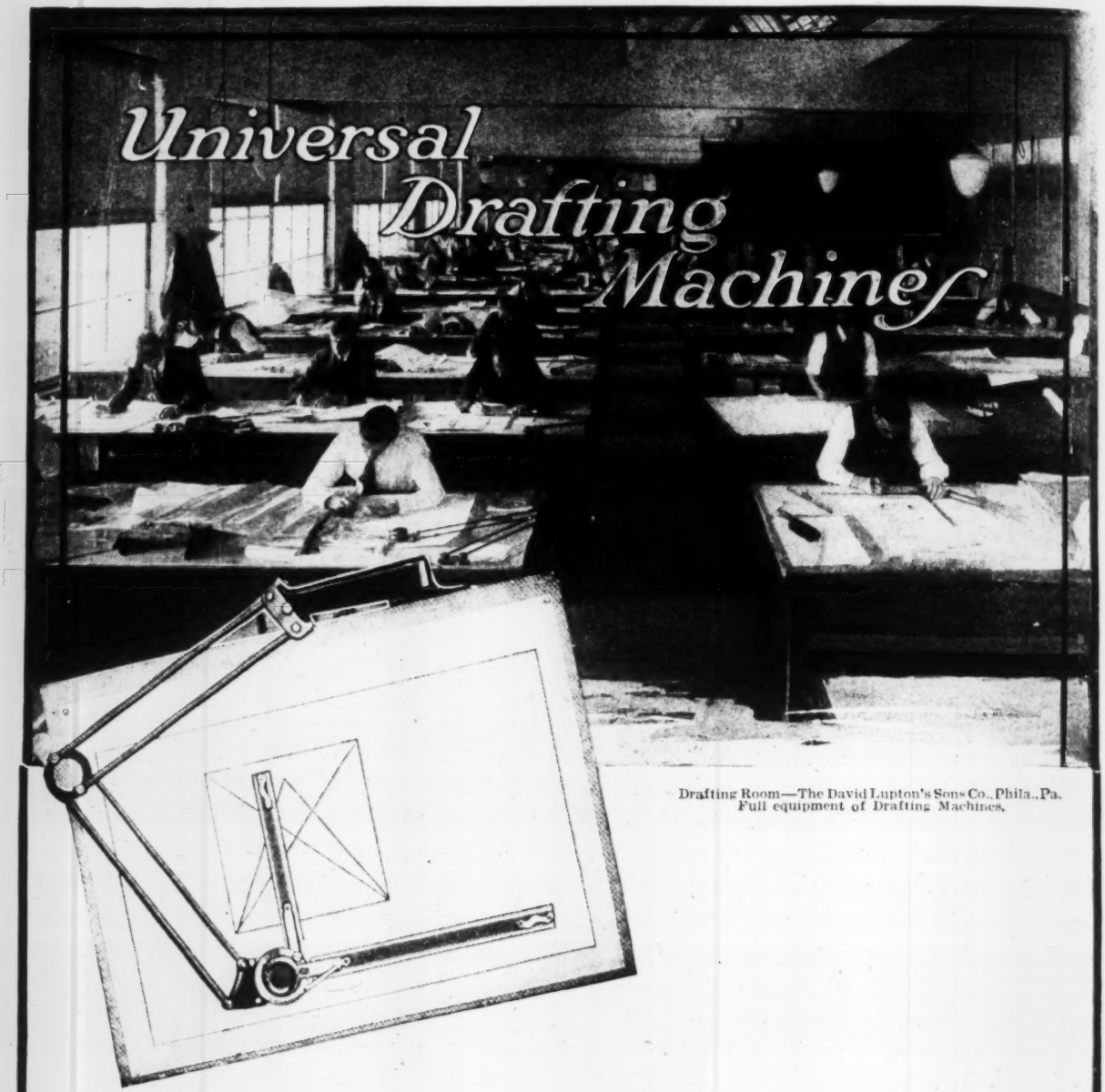
In This Issue:

Deep Pit Rock Excavation by Dragline Machines

Uniform Pressure on Building Foundation Beds
By R. Fleming

Some Observations on Filter Sands
By Abel Wolman and S. T. Powell

Britain's Huge Housing Scheme
By E. J. Mehren
Editor of Engineering News-Record



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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Water-Filter Sand Studies

THE contribution on the shrinkage of water-filter sands elsewhere in this issue has a wider appeal to engineers than its title indicates. It should stimulate other investigators in a field where too little observation and experiment has yet been undertaken. Some discussions of the ideas advanced by Messrs. Wolman and Powell will appear in a latter issue.

Fuel From Garbage Again

ABOUT this time look out for the promoter who proposes to convert the garbage of our city into fuel briquettes. Such a sentence, if there were a municipal almanac like the old farmers' almanacs, might well be inserted at some convenient place under each month. One or more Texas cities have had disappointing experiences with fuel-from-garbage promoters. Quite recently such a promoter gained serious attention from a city of considerable size in another part of the South. All such proposals should be either ignored by city councils ro referred to a competent engineer for investigation.

Annexations and City Planning

ANNEXATIONS of territory to cities are generally made either through a desire for increase in size or to secure public improvements in outlying districts. An added reason might well be the furtherance of comprehensive city planning. This does often enter in to some extent, but generally in a detached way and rarely if ever with a clear far reaching view of all that enters into city planning—major traffic streets from outlying districts to the center of the city, parks, transportation service and other utilities. The argument should not be carried as far as to make the extension of these facilities conditional on annexation, for a proper spirit of co-operation between cities and outlying districts will make regional planning possible without consolidation.

First Cost and Maintenance Expense

POSSIBILITIES of effecting large economy in maintenance by a moderate increase in first cost are illustrated by the unusual track construction adopted for the main line approach to the new union station at Chicago, described on p. 223. In such cases not only may an increase in capital outlay be demanded but in addition it may be more important to reduce the volume of maintenance work than to cut down its cost, since extensive maintenance work on busy tracks interferes with the movement of many trains. Stability and permanence of construction, therefore, are specially desirable. Settlement of track due to ballast working into the earth roadbed will be prevented by the concrete foundation slab. Wear is provided for by heavy rails and by hard, wear-resisting steel parts for special track work. A ballast bed on the concrete will absorb vibration. With this combination the work and cost of maintenance should be reduced to a minimum.

What Is an "Engineer"?

IN 22 single-spaced typewritten pages Engineering Council's Committee on Licensing of Engineers records the result of its studies of definitions of the terms "engineer" and "engineering." While the report brings together a vast amount of research data on terminology, the quest for something specific in the form of a usable definition has, thus far at least, been in vain, for the committee frankly concludes that "it was impracticable to write a definition suited to its purposes." It should be kept in mind that a definition of engineering entirely suitable for a commemorative tablet is useless as a means of defining, in the eyes of the law, the scope and character of professional practice referred to in a bill governing the registration of engineers. Admittedly the task of defining engineering, either for the one purpose or the other, is difficult, but it should not be regarded as impossible. However, the committee's work, in which the services of lawyers were enlisted, shows one thing clearly: Any definition which aims at completeness from the legal point of view is sure to be so long-winded and involved as to make impossible its use for any other than statutory purposes. On the other hand, a concise, easily remembered definition of the "slogan" type would offer an easy target for attack in the courts. Engineering today, with its almost endless ramifications into specialties unheard of several generations ago, is susceptible of no such simple description as is contained in Tredgold's famous definition. The inference drawn from the committee's findings, therefore, is that a single definition of engineering cannot be "all things to all men." Eventually, it appears, there must be two word-formulas, one for popular use and the other for legal purposes. In the meantime, the question "What is an engineer," despite the laborious efforts of Engineering Council's committee, remains unanswered.

A Source of Inspiration

APPRECIATION of the achievements of the past is fertile soil for the growth of ideals and active enthusiasm out of which present and future achievements may develop. So the art of engineering will surely progress so long as it is enlivened by a love for its historic works. In this spirit engineers may feel grateful to the small group of men who interested themselves in the maintenance of High Bridge as a notable work of an earlier period of American construction and of its famous men. If the movement that has been started succeeds, the living record of our engineering development will be richer and will serve as a greater inspiration to ourselves and our successors. In speaking here of the relation of High Bridge to engineers, it is not because we are blind to the equal or greater historic meaning of the structure to citizens of other classes, and to the city of New York as such. On the city, of course, lies the duty of proceeding in the matter, and on it also

lies the burden of expense. But it is long since accepted almost universally that the great public works which tell of the progress of civilization must never be allowed to perish if the spiritual interests of succeeding generations are not to be hurt. It may be taken for granted that New York will respect its obligation in this regard. What is of immediate moment to the engineering profession is the fact that at a moment of need engineers were there, with disinterested initiative, to do their share of urging that the famous old structure be preserved, and of devising means by which it might be done. Just as this old bridge for carrying the first Croton Aqueduct over the Harlem River is an ever-potent source of inspiration to the construction engineer, so the public-spirited act of this group of citizens is an inspiration toward further and ever fuller and more effective public service by the men of our profession.

General Langfitt Leaves Service

BY THE recent retirement, at his own request after 40 years of service, of Col. W. C. Langfitt the Corps of Engineers, U. S. Army, has suffered a great loss. As chief engineer of the American Expeditionary Forces, with rank of Major-General, he left behind him in France a record of achievement which made him one of the outstanding figures of the engineering arm of our service during the World War. In addition to our own distinguished service medal, French, British and Belgian decorations were awarded to him in appreciation of his effective work overseas during a period of two years.

As head of the biggest staff corps of the A. E. F.—175,000 officers and men at the time of the armistice—General Langfitt occupied a post of immense responsibility and power—one which called for the exercise of all of the great administrative ability and tact of which he was in such large measure possessed. To a man who had discharged successfully the duty of co-ordinating the efforts of so large a personnel as that of the Engineers in France it is understandable that the army readjustment to a peace-time basis, carrying with it reduction in rank, curtailment of opportunity and return to the more or less routine operations of the service, should prove unattractive. Such changes inevitably form the aftermath of a great war. While General Langfitt is no longer an active member of the Corps of Engineers, his work will endure as an inspiring example of organizing ability and getting results—the only things that count in military operations.

To a degree unusual in a regular officer he had a full and sympathetic understanding of the engineer who left civilian practice to assume the new and exacting duties of service in an army uniform. His consistent policy of promoting a close liaison between regular and temporary officers was productive of great good and was by no means the least of his many noteworthy accomplishments. It augurs well that the newly created Society of American Military Engineers is insistent on exactly the same policy. General Langfitt leaves the service followed by the best wishes of a host of military and civilian associates. In the words of *The Military Engineer*, "the Corps has lost one of its biggest men, a man of wide experience and ripe judgment, yet still possessed of the vigor, enthusiasm and resourcefulness of youth."

Society Reconstruction and the Conventi

A LONG-SOUGHT opportunity is before the me bers of the American Society of Civil Engine In the re-shaping of the society's government that w be discussed at the Portland, Ore., convention ne month there is a realization of what has for years be the wish of the entire society: that it might be mad possible for every member to share fairly in its admin tration. With the presentation of five different se of constitutional amendments, all elements of the socie are called upon to co-operate in internal reform.

Responsibility for guiding the reconstruction of th society's government is thereby placed on the member particularly those attending the convention. If th opportunity to do constructive work at the present junc ture is not taken, the membership will have evaded a service which it demanded as a privilege. Clear-visioned study of the amendments, in order that they may be harmonized, is required for proper discharge of this responsibility.

The occasion is not one for contention. The proposed amendments all aim at advancement of the society's interests, and bear the impress of serious endeavor. But they overlap and conflict, and the work of the day is to adjust their incompatibilities. What the convention has to deal with is not a contest but a problem, including as major elements a question of finances and a question of how to realize distributed government.

A specific obligation is laid upon the convention by the society's constitution. The proposed amendments cannot be tabled or rejected, but (except under one condition) they must go out to letter ballot either in their original form or as the convention may see fit to revise them. In so far as they are not compatible, then, it is manifestly the convention's duty to work out a final adjustment, or confusion is threatened. Confusion may result also if the adjustment is not so carried out that any one or more of the amendments may either pass or fail without affecting the others. The only way in which the convention can relieve itself of the work is by referring the amendments to a committee for report at the January meeting. This would mean half a year's loss of time.

Of the two main questions brought to the front by the amendments, that of finances is least adapted to postponement. At present cost levels the society is likely to find difficulty in maintaining the strength of its technical work, of which the *Proceedings* have hitherto been a vital element; it is reported that steps have already been taken to curtail the scope of the *Proceedings* heavily, in order to economize. Further, a working surplus should be available to permit of broadening the society's activities wherever practicable, and it needs to be remembered that entrance into the Federated American Engineering Societies will put a substantial claim on the society's treasury. Thus, the call for more funds has a foundation of hard fact, and the amendments concerned with dues merit prompt consideration. Three of the five amendments are in conflict on the subject of dues, one of them by omitting to change the present dues, while the others propose different methods of increase. It will be for the convention to weigh the needs and the possible resources, and make a choice.

With this matter, however, is involved the wiping out of the long-standing distinction between New York members and others. Placing all members on an equal

ing of financial accountability to the organization is in a way a parallel to the changes which aim to give local representation and administrative voice to all parts of the country. For this reason discussion of the first question may involve reference at the same time to the second, that of distributed government.

On this latter question two of the amendments are in competition. We say competition rather than conflict, for they differ only in minor ways. Representation on the Board of Direction, the manner of bringing the local sections into the society's government, and the creation of an advisory council to the Board, are at issue. It is unfortunate that the views on these matters were not harmonized before the amendments were drafted, since they must be harmonized by the convention, a far more difficult task. But the differences between the committee amendments and the competing set are not great, so that satisfactory adjustment should prove readily feasible.

Prospects are at hand, then, that the convention will be able to achieve such constructive work in considering the major questions of the day that an early vote will be possible. With finances and local participation in society government taken care of, and with the two important detail changes proposed in the other amendments duly weighed and acted upon, the society will have made clear progress toward increased strength and usefulness. How soon and how completely this desirable end will be realized, the action of the Portland convention will determine.

Municipal and State Housing in England and America

THERE has been much talk, but little else as yet, of municipal housing to meet the house shortage that prevails in many of our cities. How different the case is in Great Britain, where action speaks louder than words, Mr. Mehren's article on p. 217 shows.

Two strong reasons why municipal housing is going ahead so rapidly in England are (1) the dire need for houses there, the shortage being far greater in England than in America, and (2) the fact that municipal housing has been practiced for decades in Great Britain and has full warrant of law. Recent statistics, not mentioned by Mr. Mehren, show that many thousands of British families are living in one room. More striking still, as compared with American conditions, the shortage of even half way decent houses in rural England is and long has been acute. Unfortunately, all that Mr. Mehren outlines as having been undertaken thus far will go but a small way to meet Great Britain's house shortage, which runs into hundreds of thousands of dwellings and is increasing through population growth as fast as if not faster than it is being met by the present huge program.

A desire to eliminate slum areas as well as to provide better dwellings led London, Liverpool and other British cities and towns to buy and demolish ramshackle and insanitary houses years ago and to build model dwellings on the sites cleared. A common though not quite universal result has been that while the slum areas were cleared nearly all the people thus dispossessed went to other slums, aggravating evil conditions there without having their own made any better by the enforced change. This has been largely due to the fact that even though much of the cost of the land expropriated, and of streets widened or opened anew or improved, has been "written off," yet the rent for the new houses has been more than the people dispossessed were able to pay. In other words, the wages earned by these people is not enough to pay "economic rent" for small but comfortable and sanitary dwellings. The outcome has frequently been that clerks and mechanics, instead of unskilled day laborers, have rented the houses provided at municipal expense. More recent housing schemes have fared better in this respect.

The earlier municipal housing projects in Great Britain were generally authorized by special acts, applicable to specific cities. Some general legislation there was prior to 1909 but that year saw the passage of the notable Housing and Town Planning Act. Thus five years before the great war broke out comprehensive housing and town planning schemes were made possible in Great Britain. The procedure laid down was slow and cumbersome. Additional housing legislation, better suited to the needs of the day, was enacted by Parliament in 1919. In that year, too, a Ministry of Health was created and in it was vested the control of housing and town planning formerly held by the Local Government Board.

Sketchy as the foregoing notes necessarily have been (British housing literature fills many volumes) they may serve as a background for present British housing activities and throw into proper perspective the very little that has yet been done in the United States toward municipal and state housing. Canada, its provinces and municipalities have together appropriated millions for house construction but, aside from our Federal war activities, what has been done to aid housing by nation, states or cities this side of the border? Little if anything except by way of investigation. There has been state and city legislation against rent profiteering, but even this Justice Swayze, of the New Jersey Supreme Court, has declared to be unconstitutional, in language apparently broad enough, if not specifically so intended, to apply to municipal housing. In giving an opinion that resolutions aimed at profiteering landlords, passed by the City Commission of Jersey City were void, Judge Swayze said: "No doubt it is desirable that there should be houses for all citizens, but they cannot be provided legally by using without leave or confiscating the property of house owners. Housing can only be provided either in the ordinary commercial way, or by private charity." The Newark *News* comments approvingly on this decision and says that the same fate would doubtless have met a number of housing bills enacted by the lower branch of the State legislature had they become law.

If this Judge and this newspaper may be considered to voice the opinion of the American courts and press, there is little likelihood that Great Britain's immense housing scheme will be emulated here. This we say without regard to the merits of the case.

Presumably, the building and renting of houses will remain in private hands here. But it is conceivable that the risks incident to building and renting out houses in these days of high construction and capital cost, and of state and municipal regulation, will so discourage private capital that public enterprise will be forced to act. If so, much can be learned from the housing experiences of British cities and the results of the financial aid that is being rendered by the British Government.

Deep Pit Rock Excavation by Dragline Machines

Operating Ranges of 175 Ft. Horizontally and 100 Ft. Vertically Found Practicable in Rock Cuts for Miami Valley Flood Retarding Dams

NOTEWORTHY figures on radius and depth of excavation in blasted rock with dragline excavators have been obtained by the construction forces of the Miami Conservancy District. In preparing the emplacements for the outlet structures of the flood-retarding dams, rock cuts as wide as 174 ft. have been excavated without shifting the machines from the center line, and rock has been removed from a pit floor 63 ft. below the excavator track, and from the same position the machine has pulled down material from 37 ft. above track level, thus operating through a lift of 100 ft. Besides satisfying the requirements of wide reach and high lift, without rehandling the load, the dragline method at these dams has facilitated concrete construction, eliminated certain flood risks and reduced the manpower required by other methods.

Their volume of 400,000 cu.yd. places the outlet channels for the five Conservancy dams among the largest of recent rock excavation operations. Though performed in separate locations the work was virtually a single operation, because the overhead direction and planning were the same for all locations; the method of excavation was standardized for all; and equipment, procedure and supplies were interchangeable in any degree that seemed desirable. The outstanding development of the operation was to establish the dragline excavator as a tool having notable flexibility and efficiency in handling blasted rock.

Limestone and shale are the ledge rocks of the flood-retarding dam sites. Broadly speaking, the limestone is structurally hard and durable and the shale is shaky and breaks up when exposed to the elements. At all locations except Lockington, the two rocks are in combination, generally in alternate thin strata. Under the glacial till overburden, the strata, down to depths as great as 10 ft., are loose, because of partial disintegrations of the shale.

At no two of the dam locations are there the same combinations of limestone and shale. There is no shale at Lockington and the limestone belongs to a different formation than that at the other dams. It is a hard

FIG. 2. CONDUIT FLOORS CONCRETED CLOSE BEHIND EXCAVATOR OPERATIONS

and a fairly tough rock which, in the blasting, breaks up into blocks suitable for plum stones and was extensively used for this purpose in the concrete walls of the outlet structure. At Englewood the shale and

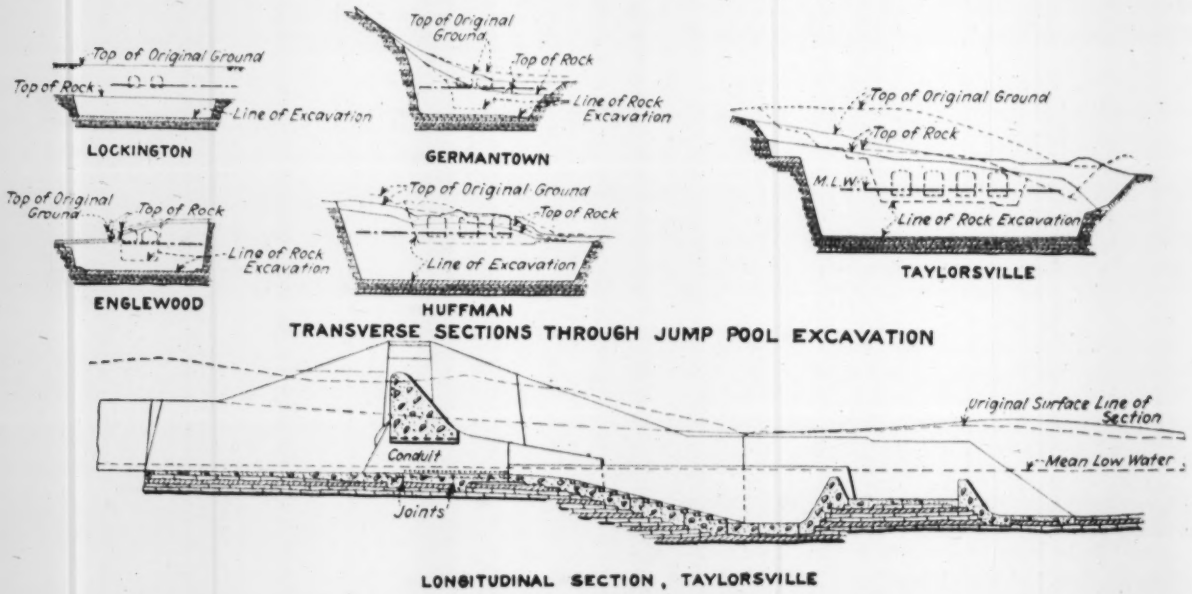


FIG. 1. TYPICAL SECTIONS OF ROCK CUTS FOR OUTLET CHANNELS

FIG. 3. PIT TRACKS ELIMINATED AND DRILL SHIFTING SIMPLIFIED

limestone are distinct strata, which separate readily into slabs a maximum of a few inches thick. For the most part, the two rocks, at Taylorsville, are in mingled thin strata, but at one level of the excavation there was a layer some 5 ft. thick, composed of limestone strata up to 13 in. firmly cemented together by ½- to ¼-in. strata of shale, so that, in blasting, the layer frequently broke into large blocks which had to be reblasted. At Huffman dam the shale and limestone are blended or mixed and the blasted fragments broke down rapidly when exposed to the weather. The Germantown rock contains only a small proportion of limestone.

Rock Used for Filling

Except at Lockington the excavated rock was of use in construction only for filling. As a filling material it had no place, of course, in the hydraulic fill dam except as a buttress fill against the earth slopes. It was used for this purpose, and, particularly at Huffman, for railway and levee embankment. These practicable uses are important to keep in mind because they point to the fact that disposal of excavated rock involved hauls of considerable length.

The ledge opening to be made was similar at all dams. It was a channel, or rock cut, in which was to be built the concrete outlet structure that passed the stream under or through the earth dam. Above the dam the cut was wide for an entrance channel, then it narrowed for the distance through the dam and finally it widened into an outlet channel below the dam. The cross-sections of Fig. 1 indicate by dotted lines the narrow conduit cuts and by full lines the wider and deeper cuts for the outlet and hydraulic jump pool. As the deeper pit for the jump pool is a characteristic of all the rock cuts it is also shown in Fig. 1 in longitudinal section for the Taylorsville dam.

Pit volumes and dimensions may be particularized briefly as follows: At Germantown and Englewood the channels were much alike. With a middle portion 30 to 35 ft. wide the ends widened out to 100 ft. and the depth ranged from 30 to 40 ft. At Englewood the cut was about 1,000 ft. long and the volume of excavation was 57,700 cu.yd.; at Germantown the corresponding figures were 800 ft. and 40,000 cu.yd. To provide for the flood flow at Huffman dam, a three-conduit outlet was required and this and the local topography called for a rock cut about 115 ft. wide and 40 ft. deep in the body and 174 ft. wide and 60 ft. deep at the outlet. The volume of excavation was 39,500 cu.yd. The Taylorsville cut was the greatest of all, involving about 250,000 cu.yd. of rock cut, and the removal of some 523,000 cu.yd. of earth overburden.

Conditions Governing Spoil Removal

With the ledge and pit conditions described, the greater rock-excavation problem was that of spoil removal. Obviously, also, only machine methods of digging and loading could be considered. The conditions governing the choice of method were fixed by the definite construction requirements; (1) that excavation and concrete construction must proceed together; (2) that the equipment must be safe from flood; (3) that the service railway requirements must be simple and (4) that economy of manpower must be kept in the forefront.

Each of the requirements stated had a constructive purpose. All the rock channels were in large part merely emplacements for concrete structures which

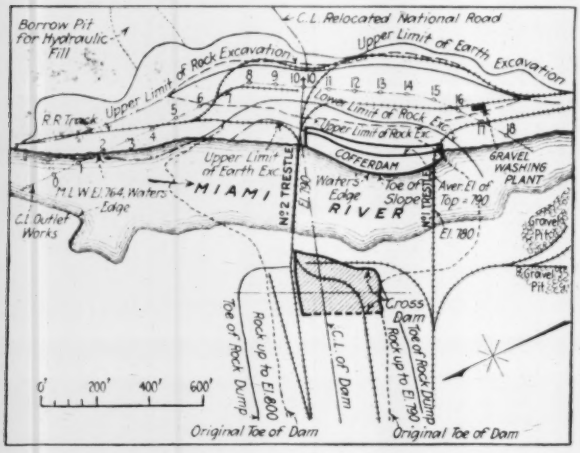


FIG. 4. PLAN OF CHANNEL EXCAVATION OPERATION AT TAYLORSVILLE

formed the real outlet channels and the completion of which, except for certain final closure parts, was necessary before any part of the channel could be used to convey water. Speed of completion, therefore, required a method of excavation which would permit as nearly as possible simultaneous concrete construction. Pit inundation was always a possible danger, if not a practical certainty, in the spring flood season. Flood safety, therefore, required an outfit for rock excavation which presented the smallest chance of being entrapped. With war in progress difficulty in securing labor was certain. Men were required for the army and for war construction and it was felt that the available labor supply should be devoted to these purposes before all others. Because labor was scarce, therefore, and also because war work had a priority right to labor, a method of excavation was required which would call for the fewest possible workmen.

Probably the third requirement stated counted for the most. Utilization of the excavated rock for railway embankment and to buttress earth dam slopes necessitated such long hauls that heavy-train railway transportation was the only economic method of disposal. Therefore, a digging and loading method was required which would lift the load high and swing it wide to cars on the surface, where permanent tracks and moderate grades for heavy spoil-train service could be maintained. Any other method, practicable for heavy rock excavation in large volumes, would require pit tracks with steep grades out of the pit and much shifting of track across the pit floor.

The excavation and loading machine, which best satisfied the four requirements enumerated and the further condition that a mobile excavator was demanded by extended longitudinal dimensions of the pits, appeared to be the dragline excavator. By traveling along the axis of the pit this machine could complete the channel to depth and width in one cut. As soon as a section of channel was excavated, as shown by Fig. 2, construction of the concrete structure could begin and thereafter concreting could follow closely the excavating. Working from the surface the machine could not be drowned out if the pit was flooded. Its wide swing and high lift permitted the service railway to be located on the surface along the side of the excavation and so be out of the reach of overflow. Only the drills in the [illegible] risked inundation and at indications of danger [illegible] could be picked up and hoisted to safety by the d[illegible] line. Surface location of the service railway elimin[illegible] all problems connected with pit track gradients, t[illegible] shifting and road-bed construction. In respect to o[illegible] ating labor, dragline methods afforded economy [illegible] by reducing track gage.

Dragline Equipment and Methods

Dragline excavation was employed at all locations except Lockington. Here the yardage was so small except in the pit only 16 ft. deep for the jump pool that heavy machine excavators could not profitably be operated. Also, the rock was a hard limestone and the large pieces were wanted as plums in the concrete so that hand loading into skips handled by the derricks installed for placing the concrete was a preferable procedure. By this arrangement the derricks lifted the plum-stone material directly into the wall forms and unloaded the skiploads of small waste rock into 5-cu.yd. cars which took it to points where riprap was wanted. The total volume of rock excavated at Lockington was less than 5,000 cu.yd.

The operating procedure at the four channels excavated by dragline was to start the machine at one end and travel down the longitudinal axis. In detail the operation differed at each dam because, chiefly, of differences in the depths and the widths of the cuts excavated. The maxima of these two dimensions were at Huffman and Taylorsville so that description of the procedure at these two locations gives the upper ranges of dragline efficiency as determined by the results of the Miami Conservancy District operations in blasted rock. At both dams the excavation of the deep pit for the hydraulic jump pool was the operation which tested radius and depth of dragline performance.

In excavating the jump pit at Huffman dam the dragline took out a channel 174 ft. wide without moving from the center line. The depth of the cut in rock was 60 ft. The machine used had a boom length of 100 ft. and operated a 4½-cu.yd. bucket. In the deepest place the bottom of the pit was 58 ft. below the excavator track and the distance from the pit bottom to spoil track was 64 ft. From one position the machine excavated and loaded 25,000 cu.yd.

At Taylorsville, besides the rock cut of 250,000 cu.yd. there were some 523,000 cu.yd. of earth overburden to be removed. Fig. 4 is a plan of the operation. About 30,000 cu.yd. of the earth cover were taken across the river by train to construct the cross-dam as described in *Engineering News-Record*, June 10, 1920, p. 1142. The remainder of the overburden was broken down by blasting and by hydraulic giants, sluiced to sumps and pumped across the river for hydraulic fill in the main dam.

The rock cut was 1,850 ft. long, had a maximum width of 380 ft. and a maximum depth of 77 ft. A top lift of overburden and loose rock was taken off by steam shovel and dragline down to elevation 789. About 6,000 cu.yd. of rock were removed in this manner to provide a rock platform at elevation 789 for the dragline excavator and the spoil-train tracks. The excavator had a 100-ft. boom and a 3½-cu.yd. bucket and loaded into trains of 12-cu.yd. dump cars. At the deepest cut the excavator took rock from 63 ft. below the track level.

To cover the full width of the pit the machine was shifted back and forth on transverse tracks.

At the maximum depth the dragline output was reduced about 50 per cent. It was increasingly difficult to load the bucket as the pit deepened, particularly in side-radius operation, when to make the reach, the bucket had to be cast beyond the boom reach. Then the bucket would often bump over the rock without digging in or would turn bottom up and have to be hauled in and cast out a second time. In this operation electric power was a disadvantage since the process of hauling in the empty bucket could not be speeded up as is possible with a steam hoist. At maximum depth and reach, no different bucket design or construction was employed. Both bucket and cable wear was increased. At Taylorsville bucket repairs ran about 3c. a yard and cable replacements about the same. Cables had an average life of 6,000 cu.yd.

Construction requirements generally imposed a method of procedure which make it difficult to present outputs which fairly represent dragline capacity in handling blasted rock. At Huffman, when the conditions rather favored high records, the 200-hp., 4½-cu.yd., 100-ft. boom machine, loaded a maximum of 115 cars in a ten-hour shift. As the 12-cu.yd. cars averaged 9 cu.yd. each, this is, in round numbers, an output of 1,000 cu.yd. An output of 700 to 800 cu.yd. per shift was frequent. At Taylorsville, with a 225-hp., 3½-cu.yd., 100-ft. boom dragline the average output per month working two shifts has been 16,740 cu.yd., or about 335 cu.yd. per shift for, say, 50 shifts a month.

Drilling and Blasting Practice

As drilling and blasting problems, the channel operations were difficult chiefly because of the streaky and shaky character of the rock. The deep-hole blasts had to be kept well within the limits of the planned dimensions of the rock cut. This required a considerable volume of cut enlargement by small blasts. A final trimming with picks was also required to remove the loose rock and get a firm backing for the concrete of the outlet structures.

Practice varied at the different locations. At Lockington the shallow cut, which permitted the concrete work to follow the excavation very closely, and the plan to utilize the rock largely for plums in the concrete, did not permit heavy blasting. Shallow holes were drilled and light charges were forced. Using 40 per cent dynamite, about 0.75 lb. per cubic yard of rock blasted was required. While the consumption of explosive was somewhat high by this procedure, it gave a good rock for plum stones and riprap and the blasting was kept close to the neat lines of the cut which reduced trimming and overbreakage.

With long narrow cuts in comparatively soft and uniform rock at Englewood and Germantown the practice in drilling and blasting was similar. Tripod drills, starting 2½ in. and finishing 1¾ in., were used. The holes were spaced about 5 ft., and also 5 ft. from the face, and each was charged with about eight sticks of 40 per cent dynamite. The trimming holes were drilled with jackhamers. The average explosive required was, at Englewood, 0.75 lb. per cubic yard, and at Germantown, 0.5 lb. per cubic yard.

With a wider and deeper cut at Huffman dam, 4-in. well and wagon drills were used, driving 20-ft. holes spaced 10 ft. apart and 10 ft. from the face. A drill averaged about 45 ft. a day. Blasting was done with 40 per cent dynamite. The average was 0.52 lb. per cu.yd.

FIG. 5. CHARACTER OF ROCK BREAKAGE FOR DRAGLINE EXCAVATION

At Taylorsville dam the rock was drilled and blasted in two lifts. About 26 ft. below elevation 789 were taken out in the first lift, and the second lift went to the bottom, a maximum of 37 ft. below the first. In a measure, the ledge conditions determined the 26 ft. depth of the first lift. Deeper holes extended below the thick limestone layer, previously described, and blasting broke the layer into large blocks which required much reblasting to fit the rock for dragline excavation. With the charge exploded in and just at the bottom of the limestone layer little reblasting was required.

Well drills were used for the main operations. These were operated by 7½-hp. electric motors using 440 volts. They averaged about 50 ft. of 4¾-in. holes a day. The holes were spaced 10 ft. each way but none was drilled nearer than 2 ft. to the bottom. At first 40 per cent dynamite was used, and later, 72½ per cent gelatin dynamite, made originally for the Italian government for war and after the armistice purchased at reduced cost by the Conservancy District. About 75 to 100 lb. was the charge for the deep holes. The average amounts of explosives used per cubic yard were 0.72 lb. of 40 per cent dynamite and 0.5 lb. of the high-power gelignite. Ordinarily, from 75 to 100 holes were fired at a shot. Drilling cost about 12c. a cu.yd. and blasting about 15c.

All work at the five dams was performed by the construction forces of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer and C. H. Locher, construction manager.

Motor Operation Costs as Affected By Highway Locati and Grade Design—Part III

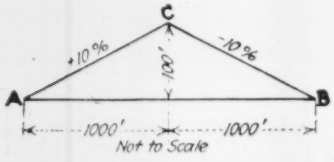
Comparison of Alternate Locations from Standpoint of Motor Operating Costs—Table of Capitalized Operating Cost on Different Grades Established

By Wilson G. Harger
Former Senior Highway Engineer Bureau of Public Roads

IT IS even more difficult to analyze alternate locations involving different distances, rise and rates of grade than the simpler cases cited at the conclusion of Part II. At present a close approximation is not possible. With more definite data on motor operation a closer approximation will be possible, but the great variety of motor vehicles will probably even then tend to weaken the value of the figures. In order to show the effect of the time factor a simple case will be outlined:

Assume two villages, *A* and *B*, 2,000 ft. apart, separated by a hill 100 ft. high with a 10 per cent grade on either side. Assume an operating cost of a truck as $24 per 10-hr. day or 4c. per minute, exclusive of fuel and oil. Assume the fuel cost as 8c. per mile, operating on the level. Assume a rolling resistance of 40 lb. per ton on the level.

Under these assumptions, if the truck starts from *A* and stops at *B*, coasting down grade from *C* to *B*, the



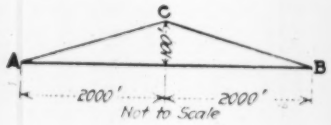
energy expended per ton of load would be approximately, (1,000, distance in feet × 240 pull in pounds) + (an allowance for the engine running free from *C* to *B*, say 10 per cent of energy required for running 1,000 ft. on the level, or 10 per cent of 40,000 ft.-lb.) = 244,000 ft.-lb.

The amount of energy required per ton of load from *A* to *B* on the level would be 2,000 (distance in feet) × 40 (pull in pounds) = 80,000, number of ft.-lb. Assuming that the fuel expenditure is directly proportional to the expenditure of energy, the fuel consumption over the hill would be $\frac{244,000}{80,000}$ or 3 times as great as on the level, or in money at 8c. per mile on the level it would be $\frac{2000}{5280} \times 8c. \times 3 = 9c.$ The fuel consumption on level = 3c.

Suppose we consider the time factor. Assume that the maximum speed on the level is regulated by law to 12 mi. per hour. The time consumed to go 2 000 ft. on the level is approximately two minutes, which amounts in money at $24 per day to about 8c. Suppose the truck makes 3 mi. per hour in low gear traveling from *A* to *C* and 6 mi. per hour coasting down the hill from *C* to *B*. The time over the hill would be six minutes or in money 24c. The total operating cost over the hill would be about 33c. and on the level 11c., or a difference of 22c.

If these assumptions were correct we could afford to increase the length of the road to 6,000 ft. on the le or three times as far to avoid the hill, so far as operating cost of the truck is concerned. The cost construction of the two routes would of course be ba anced against the operating cost.

Take the same case for the two villages *A* and 4,000 ft. apart on 5 per cent grades.



The energy over the hill per ton of load is assumed as (2,000 × 40) + (10 per cent of 2,000 × 40) = 288,000, number of ft.-lb.
The energy on the level = 160,000 ft.-lb.
Fuel consumption over the hill = 11c.
Fuel consumption on level = 6c.

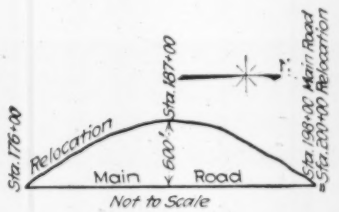
The speed climbing the 5 per cent grade would probably be about 6 mi. per hour, and about 12 mi. per hour coasting down the hill, provided the alignment is good, as the extreme control necessary on a 10 per cent grade is not required.

The time over the hill becomes approximately	6 min
The time on the level becomes approximately	4 min
The time cost over the hill approximately	24c
The time cost on the level approximately	16c
Total cost over hill	35c
Total cost on level	22c

In this case we could afford to increase the distance only 50 per cent to get a level road from the standpoint of operating cost.

As previously discussed, the value of the reduction of rise and fall decreases as the rate of grade decreases so that while in extreme cases it is desirable to increase distance to eliminate rise, this expedient must be used with care for light grades and small hills for, in general, short distance outweighs minor, intermediate rise and fall.

Simple Example.—To give a practical application of such figures we will cite a concrete example known as the Pugsley Hill relocation of the Mendon-Pittsford Road in New York State. (Figure below.) The main



straight road goes over the top of a high hill; the natural saddle is located about 600 ft. west of the main road and is 25 ft. lower than the summit on the main road. The main road used a 7 per cent cut-and-fill

...e reduction and the relocation a 4 per cent balanced ... hill location. The snow conditions are much bet... the new location, the cost of construction is less ... the rise less. Suppose we make a rough comparison ... cost of operating over the two locations:

... of Operating over Main Line (Trucks).

$$\frac{(180 \times 1,100) + (10 \text{ per cent of } 44,000 \text{ ft.-lb.})}{212,000 \text{ ft.-lb. per mile on level}} \times 8\text{c. per mile on level} = 8\text{c.}$$

... Average 6 mi. per hour, 4c. per min. (assumed) = 16c.

Total cost, = 24c.

... of Operating over New Line (Trucks).

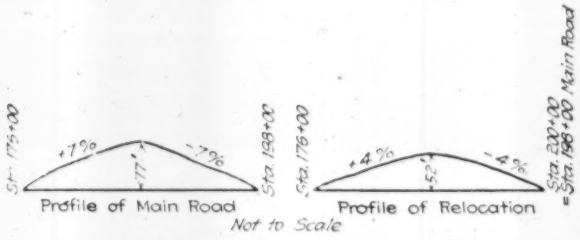
$$\frac{(120 \times 1,300) + (10 \text{ per cent of } 52,000)}{212,000} \times 0.08 = 6\text{c.}$$

... Average, 10 mi. per hour (assumed), = 12c.

Total cost, 18c.

That is, we have enough data to conclude that the operating cost on the new line is slightly less than the old main road. These data do not, however, warrant our putting a money value on this difference, as there are too many unknown factors, particularly that of time. Purely as a matter of academic interest we can carry this example a little further. This road carries today a traffic of approximately 950 motor cars and 80 trucks per day in summer. It is safe to assume that this amount of traffic applied for 250 days per year will about represent the total yearly traffic. If we assume that the pleasure cars cost about one-seventh as much to operate as the trucks we can arrive at a rough guess of the yearly saving—$3,000. This capitalized at 5 per cent would amount to $60,000, which represents theoretically the additional amount we would be justified in spending to get the new location.

As a matter of practical interest we will say that, despite the advantages of an apparently lower operating



cost, less snow trouble, and lower construction cost, this new line was not built on account of the difficulty of acquiring right-of-way. The farmer wanted $5,000 for 3½ acres because the location cut up his property. It was undoubtedly poor policy to let this stand in the way and it is probably only a question of time before the relocation will be made, as this hill controls the maximum grade on a through state route.

Quick Method of Comparison

For quick rough comparisons of such relocations we can compile a table which in the absence of really reliable data will serve the purpose. We will compute the approximate comparative cost of operating on different rates of grade. The actual cost given is of very little value but the comparative costs are close enough to give some basis for judgment on the relative value of two locations from the standpoint of motor operation.

We will make this on the basis of 11c. average motor operation on a +1 per cent grade. This is considered a reasonable cost for the proportions of truck, car and horse traffic on main roads. We will assume that the speed is reduced to one-half normal at +5 per cent and to one-fourth normal at +10 per cent grade. We will assume that the speed stays at normal on the level and remains normal on down grades to —5 per cent, and that after this rate of grade is passed that it is reduced to one-half normal at —10 per cent grade. We will assume an average fuel cost per mile on the +1 per cent grade of 3c. and that the fuel consumption is directly proportional to the theoretical energy expended in climbing. We will make some arbitrary allowances on down grades, and we will assume a theoretical drawbar pull of 40 lb. per ton on the level. The assumed cost of operation per mile on the different grades is as follows:

Level	$0 107	Level	$0 107
+ 1%	110	— 1%	104
+ 2%	126	— 2%	098
+ 3%	148	— 3%	092
+ 4%	176	— 4%	086
+ 5%	210	— 5%	083
+ 6%	244	— 6%	095
+ 7%	278	— 7%	107
+ 8%	312	— 8%	119
+ 9%	346	— 9%	131
+10%	380	—10%	143

These costs were derived as follows. The operating cost of 11c. per mile on a +1 per cent grade was apportioned as follows:

		Remarks
Fuel	$0 03	Variable fuel factor.
Tires	015	Constant distance factor.
Repairs	01	½ distance, ½ time factor.
Driver's time	015	Time factor.
Depreciation	02	½ distance, ½ time factor.
Interest on investment, insurance, garage, license, etc.	02	Time factor.
	$0 11	

To determine the operating cost on any other grade it is necessary to assume three factors: The constant

ANALYSIS OF RELATIVE OPERATING COST OF AVERAGE MOTOR TRAFFIC FOR ONE MILE OF DISTANCE ON DIFFERENT RATES OF GRADE, BASED ON 11c. PER MILE ON A ONE PER CENT GRADE

	Distance Factor $0.02 for 1% Grade			Fuel Factor $0 03 for 1% Grade		Time Factor $0 06 for 1% Grade		
Rate Grade	½ Factor Ratio for Each Rate of Grade	Cost for Each Grade		Factor Ratio for Each Rate of Grade	Cost for Each Grade	Factor Ratio	Cost for Each Grade,	Total Operating Cost
—10	1	$0 02		4	$0 12	4	$0.24	$0.380
+ 9	1	02		3½	.11	3 6	.216	.346
+ 8	1	02		3¼	.10	3 2	.192	.312
+ 7	1	02		3	.09	2 8	.168	.278
+ 6	1	02		2½	.08	2 4	.144	.244
+ 5	1	02		2½	07	2	.120	0 210
+ 4	1	02		2	06	1 6	0 096	.176
+ 3	1	02		1½	05	1 3	0 078	0 148
+ 2	1	02		1¼	04	1 1	0 066	0 126
+ 1	1	02		1	03	1	.06	0 110
Level	1	02		0 9	027	1	.06	.107
— 1	1	02		0 8	024	1	.06	0 104
— 2	1	02		0 6	018	1	.06	0 098
— 3	1	02		0 4	012	1	.06	0 092
— 4	1	02		0 2	006	1	.06	0 086
— 5	1	02		0 1	003	1	.06	0 083
— 6	1	02		0 1	003	1 2	.072	0 095
— 7	1	02		0 1	003	1 4	.084	0 107
— 8	1	02		0 1	003	1 6	.096	0 119
— 9	1	02		0 1	003	1 8	.108	0 131
—10	1	02	Engine running free	0 1	.003	2 0	.120	0 143

NOTE—If anything the fuel factor of 0.1 between the grades of —5% and —10% is a trifle low.

The time factor between the rates of grade of —5% and —10% depends very largely on the alignment, the individual driver, and whether or not he is in the habit of driving on steep grades. It is probably about right for passenger cars but too high for truck operation, and might be reduced to 1.5 at a —10% grade for truck traffic in hilly country.

The time factor on grades of +2% to +10% is too high for high power touring cars as on good alignment the normal speed is often not reduced at all up to 6%.

distance factor made up of tires, one-fourth of the repairs and one-fourth of the depreciation. The variable fuel factor and the variable time factor made up of driver's time, interest, three-quarters depreciation and three-quarters repairs. This last factor is the largest factor, it depends on the speed of the operation and is largely a matter of judgment until we have more and better data.

The data given are based on the author's best judgment in assigning arbitrary values to these factors and ratios on different grades:

	Per Mile
Time cost on a 1% grade	$0.06
Fuel cost on a 1% grade	.03
Distance factor cost (constant)	.02
Total	$0.11

TABLE OF APPROXIMATE CAPITALIZED COST AT 5%, OF YEARLY OPERATING 100 AVERAGE MOTOR CARS DAILY FOR 365 DAYS PER YEAR FOR ONE FOOT DISTANCE ON THE VARIOUS GRADES. (TIME FACTOR CONSIDERED)

Rate of Grade	Yearly Operation 100 Cars Daily (36,500 Cars Yearly)	Capitalized Yearly Operation Cost	Rate	Yearly	Capitalized
Level	$0.74	$14.80	Level	$0.74	$14.80
+ 1%	.76	15.20	— 1	.72	14.40
+ 2%	.87	17.40	— 2	.67	13.50
+ 3%	1.02	20.10	— 3	.63	12.70
+ 4%	1.22	24.40	— 4	.60	11.90
+ 5%	1.45	29.10	— 5	.57	11.50
+ 6%	1.68	33.70	— 6	.66	13.10
+ 7%	1.92	38.40	— 7	.74	14.80
+ 8%	2.16	43.20	— 8	.82	16.50
+ 9%	2.39	47.80	— 9	.90	18.10
+10%	2.62	52.50	—10	.99	19.80

NOTE—This table to be used only for general comparisons of the relative value of routes or alternate locations. The actual costs given are of very little value. The figures are based on an average operating cost for all classes of travel at 11c. per mile on a +1% grade.

To illustrate the use of this table suppose we compare the two locations over Pugsley Hill previously given.

CAPITALIZED OPERATING COST MAIN LINE

1,100, distance in feet on +7% grade, ×	$38.40 =	$42,240
1,100, distance in feet on —7% grade, ×	14.80 =	16,280
Total operating capitalized cost for 100 vehicles per day		$58,520

RELOCATION LINE

1,300 distance in feet on a +4% grade, ×	$24.40 =	$31,720
1,300, distance in feet on a —4% grade, ×	11.90 =	15,470
Total capitalized cost for 100 vehicles per day		$47,190

This indicates that possibly the relocation warrants an additional expenditure of $10,000 per 100 vehicles per day. This road averages 700 vehicles per day making the total warranted additional expenditure on the relocation for this particular volume of traffic $70,000. Even assuming that gasoline and time mean nothing to 75 per cent of the road users, this location would still be worth while.

A comparison of this kind may not warrant placing a money value on the saving in operating cost, but it certainly justifies the general conclusion that the relocation is the better line from the standpoint of operating cost. [*This is the concluding article in Mr. Harger's series.*—ED.]

American Shipbuilding During 1919-1920

During the fiscal year ending June 30, 1920, according to the U. S. Department of Commerce, the total shipping built in the United States and officially numbered by the Bureau of Navigation, aggregated 2,241 vessels of 3,860,484 gross tons as compared with 2,158 vessels and 3,734,741 gross tons for the preceding fiscal year. The peak of production was reached in the Autumn of 1919 and the following winter when, from September, 1919, to February, 1920, the output was at the rate of 4,250,000 gross tons per year.

Simple Plant Makes Good Record in Dam Construction

Favorable Location Permits Plant With Few Units To Place Concrete in 300-Ft. Dam With Small Labor Force

SIMPLE equipment, carefully planned to reduce manual operations is giving high output records in constructing the Devil's Gate concrete arch dam near Pasadena, Cal. With a force of approximately 21 workmen, aggregates have been excavated, hauled, crushed and screened and concrete has been mixed and placed at the rate of 300 cu.yd. in an 8-hour shift.

The Devil's Gate Dam is one of the structures being built by the Los Angeles County Flood Control District. It is located in the deep gorge of the Arroyo Seco, is about 300 ft. long and has a volume of about 30,000 cu.yd. of concrete. In their analysis of the construction task the contractors gave particular attention (1) to performing the construction operations to as great a degree as possible by mechanical means and (2) to simplifying the equipment and its arrangement.

About 17,000 cu.yd. of gravel, sand and rock had to be removed in preparing the foundations for the dam proper and in excavating the spillway. About 9,000 cu.yd. in the dam foundations were handled by a guy derrick having an 85-ft. boom and operating 1 cu.yd. skips loaded by hand. One foreman and 12 to 16 men loaded about 100 skips in an 8-hour shift. The spoil was piled just above the upstream face of the dam and will be leveled off to form a fill against the masonry. Two shifts a day were worked, as it was desired to get the dam completed above flood level before the rainy season. The spillway channel, which was located in a draw east of the dam, was excavated with fresno scrapers.

A high promontory, against which one end of the dam abutted, was selected, as shown by the illustration, for the site of the crushing plant, materials bins and concrete mixer. This location was well above danger from floods and was at a height which permitted about 75 per cent of the concrete in the dam to be chuted directly from the mixer and also permitted direct chuting to the spillway beyond the hill.

Suitable materials for concrete were found in the bed of the Arroyo about 1,500 ft. above the site of the dam. At that point, sand and gravel, and boulders up to 16 in. in diameter, are loaded by a steam shovel, having a ¾-cu.yd. dipper, directly into dump trucks to be hauled to the mixing plant. Three 5-cu.yd. trucks are used, traveling over 3 per cent to 4 per cent grades, and making the round trip to the mixing plant in about 12 minutes. A gyratory crusher that will handle rock up to about 16 in. in diameter is located beneath the truck-dumping platform and all materials from the trucks go through this crusher. From the crusher the materials are taken by a 70-ft. elevator to screens on top of the bunkers. These screens separate as sand all material up to ¼ in. in diameter. That which falls through the screen, with 3-in. perforations, is classified as rock, and larger material passes on to another gyratory crusher which reduces it to 1-in. size for use in the tunnel, or elsewhere where reinforcing is used. This crusher is arranged so that it requires practically no attention. The supply of oversize rock from the big plant is quite uniform and well within the capacity

MIXING PLANT ON HILL BUILDS CONCRETE DAM BY DIRECT-CHUTING

of the small crusher, and after passing through this crusher the rock is taken to bunkers by a conveyor.

From the screens the sand and rock drops into bins, the sand bin holding 80 cu.yd. and the rock bin 100 cu.yd. Immediately beneath the bins is the hopper of a 45-cu.ft. mixer which, in turn, delivers to a spouting system running out over the dam. Three cables span the gorge directly over the dam. The center cable is 1¼ in. in diameter, the others, one 30 ft. on either side, are 1 in. in diameter. Concrete chutes are suspended from the cables by block and tackle so that they can be adjusted to the desired height or swung to position over any portion of the dam. Time and labor were saved in handling the delivery chutes by arranging them so that three swivel joints and a single discharge trough could be used instead of the single swivel joint and two gates used at first. At the outset of the work there was so great a drop from the mixer to the bottom of forms that the concrete was first dropped through a wooden chute to a level from which the suspended chutes could deliver on a moderate grade.

About 75 per cent of the total concrete yardage can be poured directly from the mixer into the dam. When the dam has reached a height such that there will be insufficient grade to carry the concrete all the way across, a section at the end near the mixer will be carried up to its final height. On this short section a trestle will be built so that cars can be used to carry the concrete out to a new dumping position. From this point another section of the dam will be built up and the trestle extended to a new dumping position, and this operation will be repeated across the dam.

Because the dam is of the simple arch type, the form work is not complicated. Two carpenters were all that were required until the concrete had been carried to about half the ultimate height of the structure. The forms are wood panels, 3 x 10 ft. in size, and two men can handle them easily. They are held in place by wires running to anchors set in the last 3 ft. of concrete poured. When the forms are stripped they are raised to the new position by means of tackle suspended from the cable above.

The distribution of the men on the job is as follows: In the material pit the steam-shovel crew consists of one operator, one fireman, and two tenders. This crew can load 75 trucks or 330 cu.yd. in 8 hours. Each of the three trucks averages about 25 loads per day. The crusher crew consists of one mechanic and sub-foreman, two crusher feeders and one elevator feeder. It can handle 300 cu.yd. in an 8-hour shift. The mixer crew, which consists of one mixer man and three men feeding the hopper, handles an average of 220 batches or 250 cu.yd. per 8 hours. The concrete placing crew includes one working sub-foreman, two spreaders and one man on the chute. With this organization as much as 300 cu.yd. of concrete has been put into the dam in 8 hours. As the duties of most of the men consist of seeing that the machinery does its work properly, if the crew is several men short on some days, the output is not cut down materially so long as the machinery is working well.

J. W. Reagan is engineer for the Los Angeles Flood Control District. Bent Bros., of Los Angeles, Cal., are the contractors and L. T. Grider is superintendent in charge of construction.

Deep Piers for Missouri River Bridge

Deep piers are to be sunk for the main channel spans of the new Bismarck-Menden highway bridge across the Missouri River. The structure will comprise three through truss spans of 476 ft. c. to c. pins, and about 1,000 ft. of approach consisting of reinforced-concrete deck on wooden piles. The four river piers, spaced 481 ft. on centers, must be sunk to depths of 50 to 90 ft. below low water, passing through sand and silt to a stratum of hard clay shown by borings. The Foundation Co., of New York, has contracted to construct the piers and approaches, and according to information received from this company the open excavation method of sinking will probably be used, although air will be put on after the piers have been landed, to place the bottom and seal concrete. The two outer piers of the four will consist each of two 20-ft. circular pedestals 35 ft. apart on centers, joined by a connecting member at the top. The two middle piers will be 23 x 65-ft. rectangles. The C. A. P. Turner Co., of Minneapolis, engineer for the bridge, will direct the construction. The American Bridge Co. will build and erect the trusses. The bridge and the highway are Federal aid projects.

Provisions of the Federal Water-Power Act

Abstract of the Law Creating a Federal Power Commission and Permitting Long-Time Use of Wate Power on Government Lands and Navigable Streams

UNDER the official title of "The Federal Water-Power Act" the President on June 10, 1920, signed the long pending Water-Power Bill which provides for the long-time leasing of water-power rights on government lands and navigable streams under the jurisdiction of a new body known as the Federal Power Commission. The act itself is quite lengthy, but there is given below a fairly complete abstract of its main provisions. The abstract follows in order the paragraphs of the act itself.

A commission is created and established to be known as the Federal Power Commission, to be composed of the Secretary of War, the Secretary of the Interior, and the Secretary of Agriculture. The President shall designate the chairman of the commission. This commission shall appoint an executive secretary who is to receive a salary of $5,000 a year, and it may also request the President to detail an officer from the United States Engineer Corps to serve the commission as engineer-officer. The duties of both of these men are to be prescribed by the commission. The work of the commission is to be performed by and through the Departments of War, Interior, and Agriculture and their engineering, technical, clerical, and other personnel, except as may be otherwise provided by law. The sum of $100,000 is appropriated for such other expenses of the commission as are not to be taken care of by the three contributing departments.

Definitions of Terms in Act

The words used in the act are to have for the purposes of the act the following meanings:

"Public lands" means such lands and interests in lands owned by the United States as are subject to private appropriation and disposal under public land laws. It shall not include "reservations" as hereinafter defined.

"Reservations" means national monuments, national parks, national forests, tribal lands embraced within Indian reservations, military reservations, and other lands and interests in lands owned by the United States, and withdrawn, reserved, or withheld from private appropriation and disposal under the public-land laws; also lands and interests in lands acquired and held for any public purpose.

"Corporation" means a corporation organized under the laws of any State or of the United States empowered to develop, transmit, distribute, sell, lease, or utilize power in addition to such other powers as it may possess, and authorized to transact in the State or States in which its project is located all business necessary to effect the purposes of a license under this Act. It shall not include "municipalities" as hereinafter defined.

"State" means a State admitted to the Union, the District of Columbia, and any organized Territory of the United States.

"Municipality" means a city, county, irrigation district, drainage district, or other political subdivision or agency of a State competent under the laws thereof to carry on the business of developing, transmitting, utilizing, or distributing power.

"Navigable waters" means those parts of streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States, and which either in their natural or improved condition, notwithstanding interruptions between the navigable parts of such streams or waters by falls, shallows, or rapids compelling land carriage, are used or suitable for use for the transportation of persons or property in interstate or foreign commerce, including therein all such interrupting falls, shallows, or rapids; together with such other parts of streams as shall have been authorized by Congress for improvement by the United States or shall have been recommended to Congress for such improvement after investigation under its authority.

"Municipal purposes" means and includes all purposes within municipal powers as defined by the constitution or laws of the State or by the charter of the municipality.

"Government dam" means a dam or other work, constructed or owned by the United States for Government purposes, with or without contribution from others.

"Project" means complete unit of improvement or development, consisting of a power house, all water conduits, all dams and appurtenant works and structures (including navigation structures) which are a part of said unit, and all storage, diverting, or forebay reservoirs directly connected therewith, the primary line or lines transmitting power therefrom to the point of junction with the distribution system or with the interconnected primary transmission system, all miscellaneous structures used and useful in connection with said unit or any part thereof, and all water rights, rights of way, ditches, dams, reservoirs, lands, or interest in lands, the use and occupancy of which are necessary or appropriate in the maintenance and operation of such unit.

"Project works" means the physical structures of a project.

"Net investment" in a project means the actual legitimate original cost thereof as defined and interpreted in the "classification of investment in road and equipment of steam roads, issue of 1914, Interstate Commerce Commission," plus similar costs of additions thereto and betterments thereof, minus the sum of the following items properly allocated thereto, if and to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment: (a) Unappropriated surplus, (b) aggregate credit balances of current depreciation accounts, and (c) aggregate appropriations of surplus or income held in amortization, sinking fund, or similar reserves, or expended for additions or betterments or used for the purposes for which such reserves were created. The term "cost" shall include, in so far as applicable, the elements thereof prescribed in said classification, but shall not include expenditures from funds obtained through donations by States, municipalities, individuals, or others, and said classification of investment of the Interstate Commerce Commission shall in so far as applicable be published and promulgated as a part of the rules and regulations of the commission.

The duties of the commission are detailed as follows:

(a) To make investigations and to collect and record data concerning the utilization of the water resources of any region to be developed, the water power industry and its relation to other industries and to interstate or foreign commerce, and concerning the location, capacity, development costs, and relation to markets of power sites, and whether the power from Government dams can be advantageously used by the United States for its public purposes, and what is a fair value of such power, to the extent the commission may deem necessary or useful for the purposes of the act.

In order to aid the commission in determining the net investment of a licensee in any project, the licensee shall, upon oath, within a reasonable period of time, to be fixed by the commission, after the construction of the original project or any addition thereto or betterment thereof, file with the commission, in such detail as the commission may require, a statement in duplicate showing the actual legiti-

the cost of construction of such project, addition, or betterment, and the price paid for water rights, rights of way, lands, or interest in lands. The commission shall deposit one of said statements with the Secretary of the Treasury. The licensee shall grant to the commission or to its duly authorized agent or agents, at all reasonable times, free access to such project, addition, or betterment, and to all maps, profiles, contracts, reports of engineers, accounts, books, records, and all other papers and documents relating thereto.

(b) To cooperate with the executive departments and other agencies of State or National Governments in such investigations; and for such purpose the several departments and agencies of the National Government are authorized and directed upon the request of the commission, to furnish such records, papers, and information in their possession as may be requested by the commission, and temporarily to detail to the commission such officers or experts as may be necessary in such investigations.

(c) To make public from time to time the information secured hereunder, and to provide for the publication of its reports and investigations in such form and manner as may be best adapted for public information and use. The commission, on or before the first Monday in December of each year, shall submit to Congress for the fiscal year preceding a classified report showing the permits and licenses issued under the act, and in each case the parties thereto, the terms prescribed, and the moneys received, if any, on account thereof.

(d) To issue licenses to citizens of the United States, or to any association of such citizens, or to any corporation organized under the laws of the United States or any State thereof, or to any State or municipality for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, power houses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation, and for the development, transmission, and utilization of power across, along, from or in any of the navigable waters in the United States, or upon any part of the public lands and reservations in the United States (including the territories), or for the purpose of utilizing the surplus water or water power from any government dam, except as herein provided: *Provided*, that licenses shall be issued without any reservation only after a finding by the commission that the license will not interfere or be inconsistent with the purpose for which such reservation was created or acquired, and shall be subject to and contain such conditions of the secretary of the department under whose supervision such reservation falls as shall be necessary for the adequate protection and utilization of such reservation:

Provided Further, that no license affecting the navigable capacity of any navigable waters of the United States shall be issued until the plans for the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of War. Whenever the contemplated improvement is, in the judgment of the commission, desirable and justified in the public interest for the purpose of improving or developing a water way or waterways for the use or benefit of the state or foreign commerce, a finding to that effect shall be made by the commission.

Provided further, that in case the commission shall find that any government dam may be advantageously used by the United States for public purposes in addition to navigation, no license therefor shall be issued until two years after it shall have reported to Congress the facts and the conditions relating thereto, except that this provision shall not apply to any government dam constructed prior to the passage of this act:

And Provided Further, that upon the filing of any applications for a license which has not been preceded by a preliminary permit under subsection (e) of this section notice shall be given and published as required by the proviso of such subsection.

(e) To issue preliminary permits for the purpose of enabling applicants for license hereunder to secure the data and to perform the acts required in this act, provided, however, that upon the filing of any application for a preliminary permit by any person, association, or corporation the commission, before granting such application, shall at once give notice of such application in writing to any state or municipality likely to be interested in or affected by such application; shall also publish notice in such application in the local newspaper.

(f) To prescribe rules and regulations for the establishment of a system of accounts and for the maintenance thereof by licensees hereunder; to examine all books and accounts of such licensees at any time; to require them to submit at such times as the commission may require statements and reports including full information as to assets, liabilities, capitalization, net investment and reduction thereof, gross receipts, interest due and paid, depreciation and other reserves, cost of project, cost of maintenance and operation of the project, cost of renewals and replacements of project works, and as to depreciation of the project works and as to production, transmission, use and sale of power; also to require any licensee to make adequate provision for currently determining such costs and other facts.

(g) To hold hearings and to order testimony to be taken in connection with the application for any permit or license, and to require by subpoena the attendance and testimony of witnesses in the production of documentary evidence.

Preliminary permits issued under the act are to be for the sole purpose of maintaining priority of application for license for a period not exceeding three years as in the discretion of the commission it may be necessary to make an examination of the surveys, preparing plans, etc. Each such permit shall set forth the conditions under which priority shall be maintained and license issued, and the permit may not be transferable. It may be cancelled by the commission upon failure of the permittee to comply with the conditions.

Licensing Under the Act

The licenses under the act are to be issued for a period not exceeding fifty years. Each such license is to be continued upon acceptance by the licensee of all the terms and conditions of the act and such further conditions, if any, that the commission shall prescribe in conformity with the act. Licenses may be revoked only for the reasons and in the manner prescribed under the provisions of the act, and may be altered or surrendered only upon mutual agreement between the licensee and the commission after ninety days' public notice. In issuing permits or licenses the commission is to give preference to applications by States and municipalities. Between other applicants the commission is to give preference to the applicant the plans of which it finds and determines the best adapted to develop, conserve and utilize in the public interest the navigation and water resources of the region. Whenever in the judgment of the commission the development of any project should be undertaken by the United States itself, the commission shall not approve any applications for such project by any one else, but shall cause to be made such examination of the project as it may deem necessary and shall submit its findings to Congress with such recommendations as it may deem appropriate concerning construction of such project.

No voluntary transfer of any license or the rights thereunder granted shall be made without the written approval of the commission, and any successor or assign of the rights of such licensee shall be subject to all the conditions of the license under which such rights were held by such licensee.

Each applicant for a license has to submit to the commission:

(a) Such maps, plans, specifications, and estimates of cost as may be required for a full understanding of the proposed project. Such maps, plans, and specifications when approved by the commission shall be made a part of the license; and thereafter no change shall be made in said maps, plans, or specifications until such changes shall have been approved and made a part of such license by the commission.

(b) Satisfactory evidence that the applicant has complied with the requirements of the laws of the State or States within which the proposed project is to be located with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes and with respect to the right to engage in the business of developing, transmitting, and distributing power, and in any other business necessary to effect the purposes of a license under the act.

All licenses issued under the act are conditioned as follows:

(a) That the project adopted, including the maps, plans, and specifications, shall be such as in the judgment of the commission will be best adapted to a comprehensive scheme of improvement and utilization for the purpose of navigation, of water-power development, and of other beneficial public uses; and if necessary in order to secure such scheme the commission shall have authority to require the modification of any project and of the plans and specifications of the project works before approval.

(b) That except when emergency shall require for the protection of navigation, life, health, or property, no substantial alteration or addition not in conformity with the approved plans shall be made to any dam or other project works constructed hereunder of a capacity in excess of one hundred horsepower without the prior approval of the commission; and any emergency alteration or addition so made shall thereafter be subject to such modification and change as the commission may direct.

(c) That the licensee shall maintain the project works in a condition of repair adequate for the purposes of navigation and for the efficient operation of said works in the development and transmission of power, shall make all necessary renewals and replacements, shall establish and maintain adequate depreciation reserves for such purposes, shall so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the commission may from time to time prescribe for the protection of life, health, and property. Each licensee hereunder shall be liable for all damages occasioned to the property of others by the construction, maintenance, or operation of the project works or of the works appurtenant or accessory thereto, constructed under the license, and in no event shall the United States be liable therefor.

(d) That after the first twenty years of operation out of surplus earned thereafter, if any, accumulated in excess of a specified reasonable rate of return upon the actual, legitimate investment of a license in any project or projects under license the licensee shall establish and maintain amortization reserves, which reserves shall, in the discretion of the commission, be held until the termination of the license or be applied from time to time in reduction of the net investment. Such specified rate of return and the proportion of such surplus earnings to be paid into and held in reserve shall be set forth in the license.

(e) That the licensee shall pay to the United States reasonable annual charges in an amount to be fixed by the commission for the purpose of reimbursing the United States for the costs of the administration of this act, for recompensing it for the use, occupancy and enjoyment of its lands or other property, and for the expropriation to the Government of excessive profits until the respective States shall make provision for preventing excessive profits or for the expropriation thereof to themselves, or until the period of amortization as herein provided is reached, and in fixing such charges the commission shall seek to avoid increasing the price to the consumers of power by such charges, and charges for the expropriation of excessive profits may be adjusted from time to time by the commission as conditions may require.

Provided, that when licenses are issued involving the of government dams or other structures all over the U States or tribal lands embraced within Indian rese tions the commission shall fix a reasonable annual cha for the use thereof and such charges may be readjusted the end of twenty years after the beginning of operati and at periods of not less than ten years thereafter manner to be prescribed in each right.

Provided, that the licenses for the development, tra mission or distribution of power by States or municipali shall be issued and enjoyed without charge to the exte that such power is sold to the public without profit or used by such state or municipality for State and municip purposes.

(f) That whenever any licensee hereunder is directly benefited by the construction work of another license or of the United States of a storage reservoir or other headwater improvement, the commission shall require as a condition of the license that the licensee so benefited shall reimburse the owner of such reservoir or other improvement.

Combinations, agreements, arrangements or understandings expressed or implied to limit the output of electrical energy to restrain trade, or to fix, maintain, or increase prices for electrical energy or service are prohibited. Projects of under 100 hp. may in the judgment of the commission not be required to follow the provisions of the act. Where the dam or other project works are to be across, along or in any of the navigable waters of the United States the commission may include in the license any one or more of the following provisions or requirements:

(a) That such licensee shall, to the extent necessary to preserve and improve navigation facilities, construct, in whole or in part, without expense to the United States, in connection with such dam, a lock or locks, booms, sluices, or other structures for navigation purposes, in accordance with plans and specifications approved by the Chief of Engineers and the Secretary of War and made part of such license.

(b) That in case such structures for navigation purposes are not made a part of the original construction at the expense of the licensee, then whenever the United States shall desire to complete such navigation facilities the licensee shall convey to the United States, free of cost, such of its land and its rights of way and such right of passage through its dams or other structures, and permit such control of pools as may be required to complete such navigation facilities.

(c) That such licensee shall furnish free of cost to the United States power for the operation of such navigation facilities, whether constructed by the licensee or by the United States.

Where navigable waters are concerned the commission may grant the application with the provisions expressed in the license that the licensee will install the necessary navigation structures if the government fails to make provision therefor within a fixed time, and shall at the same time, if it deems desirable, submit to Congress a recommendation that the government carry out the navigation necessities.

The licensee is required to commence the construction of project works within the time fixed by the license, which shall not be more than two years from the date of the license and has to prosecute it with due diligence. The period for commencement of the construction may be extended once, but not longer than two additional years. Failure to observe the time clauses of the license will cause cancellation of the license. Any project once started on which the license is cancelled is to be made the subject of a suit in equity by the Attorney General for the revocation of the license, the

...e of the works, or such other equitable relief as the ... may demand.

The exact wording of the recapture provisions of the ... is as follows:

Upon not less than two years' notice in writing from ... commission, the United States shall have the right ... on or after the expiration of any license to take over and ... hereafter to maintain and operate any project or projects ... or the right to take over upon mutual agreement with ... licensee all property owned and held by the licensee then ... valuable and serviceable in the development, transmission ... or distribution of power, and which is then dependent for ... its usefulness upon the continuance of the license, together with any lock or locks or other aids to navigation constructed at the expense of the licensee, upon the condition that before taking possession it shall pay the net investment of the licensee in the project or projects taken, not to exceed the fair value of the property taken, plus such reasonable damages, if any, to property of the licensee valuable, serviceable, and dependent as above set forth but not taken, as may be caused by the severance therefrom of property taken, and shall assume all contracts entered into by the licensee with the approval of the commission. The net investment of the licensee in the project or projects so taken and the amount of such severance damages, if any, shall be determined by agreement between the commission and the licensee, and in case they can not agree, by proceedings in equity instituted by the United States in the district court of the United States in the district within which any such property may be located: *Provided*, That such net investment shall not include or be affected by the value of any lands, rights of way, or other property of the United States licensed by the commission under this Act, by the license, or by good will, going value, or prospective revenues: *Provided further*, That the values allowed for water rights, rights of way, lands, or interest in lands shall not be in excess of the actual reasonable cost thereof at the time of acquisition by the licensee: *Provided*, That the right of the United States or any State or municipality to take over, maintain, and operate any project licensed under the act at any time by condemnation proceedings upon payment of just compensation is hereby expressly reserved.

That if the United States does not, at the expiration of the original license, exercise its right to take over, maintain, and operate any project or projects of the licensee, the commission is authorized to issue a new license to the original licensee upon such terms and conditions as may be authorized or required under the then existing laws and regulations, or to issue a new license under said terms and conditions to a new licensee, which license may cover any project or projects covered by the original license, and shall be issued on the condition that the new licensee shall, before taking possession of such project or projects, pay such amount, and assume such contracts as the United States is required to do: *Provided*, That in the event the United States does not exercise the right to take over or does not issue a license to a new licensee, or issue a new license to the original licensee, upon reasonable terms, then the commission shall issue from year to year an annual license to the then licensee under the terms and conditions of the original license until the property is taken over or a new license is issued as aforesaid.

Provision is made for the taking over of any project by the government in time of war with due recompense to the licensees.

Control of Rates

The control of rates is vested in the separate state regulatory bodies. The provisions of the law in this respect are as follows:

That as a condition of the license, every licensee hereunder which is a public-service corporation, or a person, association, or corporation owning or operating any project and developing, transmitting, or distributing power for sale or use in public service, shall abide by such reasonable regulation of the services to be rendered to customers or consumers of power, and of rates and charges of payment therefor, as may from time to time be prescribed by any duly constituted agency of the State in which the service is rendered or the rate charged. That in case of the development, transmission, or distribution, or use in public service of power by any licensee hereunder or by its customer engaged in public service within a State which has not authorized and empowered a commission or other agency or agencies within said State to regulate and control the services to be rendered by such licensee or by its customer engaged in public service, or the rates and charges of payment therefor, or the amount or character of securities to be issued by any of said parties, it is agreed as a condition of such license that jurisdiction is hereby conferred upon the commission, upon complaint of any person aggrieved or upon its own initiative, to exercise such regulation and control until such time as the State shall have provided a commission or other authority for such regulation and control: *Provided*, That the jurisdiction of the commission shall cease and determine as to each specific matter of regulation and control prescribed in this section as soon as the State shall have provided a commission or other authority for the regulation and control of that specific matter.

That when said power or any part thereof shall enter into interstate or foreign commerce the rates charged and the service rendered by any such licensee, or by any subsidiary corporation, the stock of which is owned or controlled directly or indirectly by such licensee, or by any person, corporation, or association purchasing power from such licensee for sale and distribution or use in public service shall be reasonable, nondiscriminatory, and just to the customer and all unreasonable discriminatory and unjust rates or services are hereby prohibited and declared to be unlawful; and whenever any of the States directly concerned has not provided a commission or other authority to enforce the requirements of this section within such State or to regulate and control the amount and character of securities to be issued by any of such parties or such States are unable to agree through their properly constituted authorities on the services to be rendered or on the rates or charges of payment therefor, or on the amount or character of securities to be issued by any of said parties, jurisdiction is hereby conferred upon the commission, upon complaint of any person aggrieved, upon the request of any State concerned, or upon its own initiative to enforce the provisions of this section, to regulate and control so much of the services rendered, and of the rates and charges of payment therefor as constitute interstate or foreign commerce and to regulate the issuance of securities by the parties included within this section, and securities issued by the licensee subject to such regulations shall be allowed only for the bona fide purpose of financing and conducting the business of such licensee.

Prior permits or valid existing rights-of-way, etc., are not to be affected by any of the provisions of the act, but any person holding such permits, etc., may apply for a license under the terms of the act provided that when application is made for a license for a project already constructed the fair value of such project determined as provided in the act shall for the purposes of the act and of said license be deemed to be the amount to be allowed as the net investment of the applicant in such project or projects as of the date of such license, or as of the date of such determination if license has not been issued. Such fair value may in the discretion of the commission be determined by mutual agreement between the commission and the applicant, or, in case they cannot agree, jurisdiction is conferred upon the district court of the United States in the district within such project is located upon the application of either party to determine the amount of such fair value.

Special provision for non-navigable waters is made as follows:

That any person, association, corporation, State, or municipality intending to construct a dam or other project works across, along, over, or in any stream or part thereof, other than those defined herein as navigable waters, and over which Congress has jurisdiction under its authority to regulate commerce between foreign nations and among the several States, may in their discretion file declaration of such intention with the commission, whereupon the commission shall cause immediate investigation of such proposed construction to be made, and if upon investigation it shall find that the interests of interstate or foreign commerce would be affected by such proposed construction, such person, association, corporation, State, or municipality shall not proceed with such construction until it shall have applied for and shall have received a license under the provisions of this Act. If the commission shall not so find, and if no public lands or reservations are affected, permission is hereby granted to construct such dam or other project works in such stream upon comoliance with State laws.

Nothing in the act is to be construed as affecting the laws of the respective states relating to the control, appropriation, use, or distribution of water used in irrigation, or for municipal or other purposes, or any vested rights acquired therein.

The protection of licensees against the future action of Congress is given in the following paragraph:

That the right to alter, amend, or repeal this act is hereby expressly reserved; but no such alteration, amendment, or repeal shall affect any license theretofore issued under the provisions of this act, or the rights of any licensee thereunder.

Mailing Case for Water Bacteria Samples

To avoid the expense of packing water samples for bacterial analysis in ice and shipping by express the Provincial Board of Health of Quebec has for two years past used a mailing case for daily sampling purposes. During that time nearly 18,000 samples, principally from purification plants, have been handled satisfactorily. The case and its use were described in a paper presented to the American Water Works Association in June by M. H. McCrady, chemist and bacteriologist, Superior Board of Health of the Province of Quebec, Montreal, P. Q. Mr. McCrady has supplied the following abstract of his paper:

Small mailing cases, with four cork-stoppered tubes in each, the tubes containing a little concentrated lactose medium, are shipped in lots of 20 or 30 to the sample collector, who each day fills the four tubes of one case with the water to be examined. Each tube is filled only to a mark on the tube, such that 5 c.c. of water are placed in the tube. The case is then mailed to the laboratory, where a small inverted vial is placed in each tube, the tube tipped to fill the vial with the liquid in the tube, and the whole then incubated at 37 deg. C. in the usual manner, to obtain a presumptive test for organisms of the Colon group. The advantages of this system of sampling and analysis are: (1) Slight cost of outfits, as ordinary specimen vials constitute the only glassware required. The mailing-case is simply the outside can of the usual type of sputum mailing case employed by many laboratories. (2) Slight cost oftransportation. The case is shipped to the laboratory for the insignificant sum of 3c. (3) The excellent service of the mails is employed. (4) The labor of handling samples at the laboratory is reduced to a minimum, for the cases are handled at the rate of about one a minute. (5) The slight labor involved in collecting samples results in surprising regularity in such collection. (6) The results are quantitative, 4 samples of 5 c.c. being taken daily.

Vertical Curves for Coal Piers and Hump Yards

Sharp Circular and Parabolic Curves Connect Steep Grades of Cable and Gravity Inclines—Minimum Radius 82 Ft.

IN DESIGNING the track layout for coal shipping piers an important consideration is the radius and length of vertical curves at the ends of the steep grades for cable inclines and gravity tracks, and for the kick-backs where the direction of car travel is reversed. The use of vertical curves under such conditions is very different from their use on main lines, owing to the steep grades, the restricted length and the exceptional operating methods at coal piers. As very little published information on this subject is available the following particulars of recent practice will be useful for record or reference.

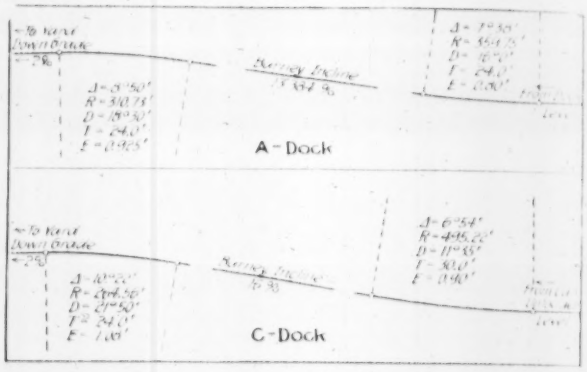


FIG. 1. VERTICAL CURVES ON COAL PIER INCLINES, LEHIGH VALLEY RAILROAD

To insure safe and free movements of cars over the sharp changes in grade, it is necessary to avoid undue strain on the center plates or king pins of the trucks and insure against fouling of brake rigging, hopper doors or other low hanging parts of cars with the track or the cable haulage system. If cars are operated in pairs or in trains there is also the factor of possible separation of the couplings in passing over the change of grade. The profile of grades and curves at each pier is selected to suit local conditions of construction and operation. In some cases it is the practice to lay out the profile of each curve and its adjacent grades on a very large scale and to plot the cars upon this, in order to see that there will be no interference.

On the new coal pier of the Central R.R. of New Jersey at Jersey City, N. J., which was described in *Engineering News-Record*, April 15, 1920, p. 759, parabolic, instead of circular, vertical curves are used, each offset from the theoretical grade line to the curve profile, being proportional to the square of the distance from the P.C. or P.T. of the curve. The length of curve varies with the grades. Thus, a curve 30 ft. long connects the 1 per cent gravity track for loaded cars with the 12 per cent cable incline and a 35-ft. curve connects this incline with the level track of the car dumping machine. At the end of the level track a 30-ft. curve connects with the empty descending grade (8 per cent from one machine and 11 per cent from the other), at the foot of which a 35-ft. curve connects with the 1½ per cent ascending grade to the kick-

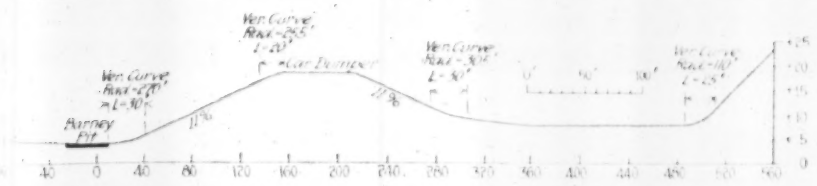


FIG. 2. VERTICAL CURVES ON GREENWICH COAL PIER

kick track. A 45-ft. vertical curve connects this 11 per cent grade with the 18 per cent grade of the kickback. This arrangement will be understood by reference to the profiles in the article mentioned above.

Circular curves are used at the Buffalo coal pier of the Delaware, Lackawanna & Western R.R. The loaded cars pass over a curve 21 ft. long from the 2 per cent gravity track to the 12 per cent incline at the head of which a curve 24 ft. long and of 200 ft. radius connects with the level track of the car dumper. For the loaded car kickback, however, a curve of 82 ft. radius and 32 ft. length is used. This appears to be the minimum radius for vertical curves. Fig. 1 shows profiles at two of the coal docks of the Lehigh Valley R.R., at Perth Amboy, N. J., where cars are handled coupled together. The minimum radius is 264 ft. at the head of one incline, as with sharper curves there will be trouble from the uncoupling of the cars. For cars operated singly this radius could be reduced materially. On coal piers of the Norfolk & Western R.R. the radius of vertical curves is 200 ft. at the foot of the barney or cable incline, 185 ft. from the head of the incline into the car dumper and from 185 to 200 ft. where cars run by gravity through a kickback.

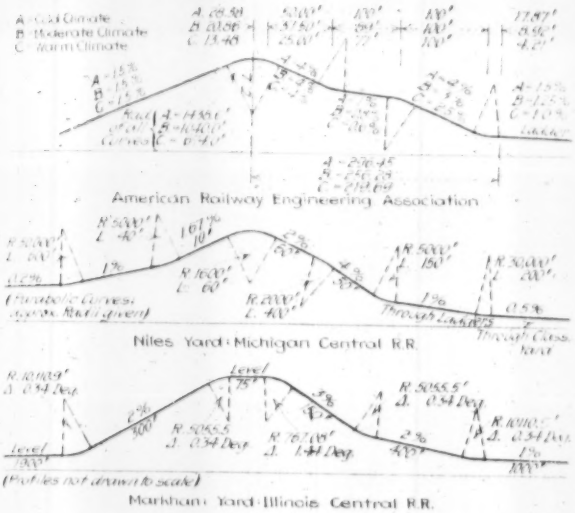


FIG. 3. VERTICAL CURVES AND GRADES OF SWITCHING HUMPS

On the Canton coal pier of the Pennsylvania R.R., at Baltimore, Md., the loaded cars run into a kickback about 120 ft. long, which is built on a vertical curve of 405 ft. radius and from which the cars are delivered to the cable incline leading to the car dumper. This incline has a grade of 13.2 per cent, with vertical curves of 288 ft. and 224 ft. at bottom and top, the length of curve being about 32 and 27 ft. respectively. On the Greenwich coal pier of the same road, at Philadelphia, the vertical curves are of 305 to 110 ft. radius, as shown in Fig. 2. Neither of these piers has a vertical curve at the connection of the level track of the car dumper with the empty gravity track, which track on the Canton pier has a grade of 4.1 per cent. On the Greenwich pier, however, there is a slight easing of the grade at the top of the 11 per cent gravity track.

The sharpest curve noted for the foot of a cable incline is 156 ft. on the car dumping pier of the Philadelphia & Reading R.R. at Port Reading, N. J. This curve connects a level yard track with the 11 per cent incline grade, a 309 ft. curve connecting the head of the incline with the level track leading through the car dumping machine.

Vertical curves on hump tracks for gravity switching are of considerably longer radius than those of coal pier tracks, owing to the flatter grades and the operating conditions, but their radius is much shorter than that of vertical curves on main line profiles. For switching humps the American Railway Engineering Association recommends three separate profiles for cold, moderate and warm climates, with grades connected by vertical curves of 1,436 ft., 1,040 ft. and 674 ft. radius respectively. Profiles of these arrangements of switching humps (not drawn to scale) are shown in Fig. 3, which shows also similar profiles of the humps at the Niles yard of the Michigan Central R.R. and the Markham yard of the Illinois Central R.R. (see *Engineering News-Record* of Jan. 8, 1920, p. 81, and Aug. 5, 1918, p. 313). The foregoing table gives the figures for the two yards mentioned.

VERTICAL CURVES AND GRADES ON SWITCHING HUMPS

	Niles Yard—M C R R			Markham Yard—I C R R			
	Length, Ft.	Radius Vert. Curve, Ft.	Grade, per Cent	Length, Ft.	Engineer's Angle of Vert. Curve, Deg.	Radius Vert. Curve, Ft.	Grade, Per
Foot of ascent	600	50,000		0° 34′	10,110	9	
Ascent	2,800		1 00′	500			2 0
Ascent	40	5,000					
Ascent	10		1 67				
Top of ascent				150	0° 34′	5,055	5
Summit	60	1,600		75			Level
Top of descent				150	1° 44′	262	1
Accelerating grade	60		2 00	150			3 0
Accelerating grade	40	2,000			0° 34′	5,055	5
Accelerating grade	50		4 00	400			2 0
Foot of accel. grade	150	5,000		0° 34′	10,110	9	
Through ladders	1,300		1 00	1,000			1 0
End of ladders	200	30,000					
Through class yard	2,100		0 50				

These three profiles represent two types of humps. At the Markham yard the summit is a level stretch with a vertical curve at each end, but in the other designs the summit is formed by a single vertical curve. Further, the Niles profile shows a steepening of the ascending slope at its connection with the summit curve, the purpose of this arrangement being to close the cars together and thus facilitate uncoupling for the gravity movement. Parabolic curves are used at the Niles yard, the figures in the table and on the cut indicating the approximate radii. The break of grade on the descending side of the hump of the American Railway Engineering Association's profile is for the location of track scales.

The Surface Shrinkage of Rapid Filter Sand Beds

A Discussion of the Causes and the Importance of the Varying Degree of Adsorptive Power of Sand Grains—Application of Colloid Chemistry Concepts to a Sanitary Engineering Problem

ABEL WOLMAN AND SHEPPARD T. POWELL
Division Engineer, Division of Special Investigations — Resident Engineer
Bureau of Sanitary Engineering Maryland State Department of Health, Baltimore, Md.

The authors suggest as the cause of the surface shrinkage of filter sand beds the presence of highly adsorptive sands. A quantitative method for measuring the adsorptive capacities of sand grains is described. By the use of such a measure, it is found that sands, apparently the same in character, disclose great differences in activity. Current methods of granulometric analysis do not supply all of the data which these investigations indicate should be known in regard to filter media, since such methods measure apparent size and not retentive or adsorptive capacity. This latter characteristic is frequently a concomitant of small-size sand grains, but is not necessarily of low value in grains of apparently large size or low specific area. The presence of highly-adsorptive sand is thought to be responsible for sand-bed contraction, since similar explanations have been developed in other fields to account for the phenomena of contraction, cementation, plasticity and cracking. The importance of the foregoing observations lies as much in the unforeseen disclosure of the powerful internal forces within the sand bed, and in the development of a new conception of the variability of sands, which usual procedures do not differentiate, as in the solution of the special problem of sand-bed shrinkage. It is concluded that the adsorptive capacity of sands is dependent upon their internal structure and active surface and not upon the presence of so-called colloidal films. Attention is called also to the value of studying other engineering problems, such as hydraulic-fill dams, subaqueous structures, and highways, from the standpoint of physical chemistry.

THE problems encountered by engineers in the purification of water have been interpreted usually in the light of chemical and biological laws. It is only within recent years that any explanation, for instance, of the mechanism of filtration and the function of the sand medium therein has been predicated upon purely physico-chemical concepts. The recent occurrence of such a condition as the surface contraction of a sand bed, therefore, results in opening up to the water-works engineer an interesting and unexplored field of research which leads one into the strange lands of ceramics, agriculture, and theoretical physical chemistry. The present paper should have its interest for the filtration engineer not so much in the presentation of the specific problem of sand bed shrinkage, as in the development of data and concepts borrowed from allied sciences. A brief survey of the materials with which the water-works man attempts to bring about purification of water indicates at once an array of particles of colloid dimension so striking as to cause one to wonder why the usual phenomena encountered have been so little studied by intensive colloid chemical methods. Within the filter bed there still remains to be probed a colloid microcosm of gels of silica, alumina and kindred other particles.

To engineers and scientists in general the data here discussed may serve as an introduction to methods of interpretation and investigation which as yet are but rarely employed. The significance of colloid particles in the hydraulic construction of dams, in the location of subaqueous structures, in the building of highways, in the flotation of ores and in many other engineering problems, where the state of subdivision of the materials employed frequently determines success or failure, cannot be too greatly stressed. The problems described in this paper are not peculiar to the field of filtration engineering. The underlying principles, though specific and restricted in their setting, are common to that vast twilight zone, which Ostwald, less than a decade ago, so aptly named the "world of neglected dimensions."

In the course of the routine control of the operation of a number of water filtration plants in the State of Maryland, there have come to our notice within the past few years various phenomena of filter sand action which appeared to require some laboratory study. The investigation of some of the little-discussed properties of sands used in filter beds has been carried out in the Bureau of Sanitary Engineering of the Maryland State Department of Health under the general supervision of the chief engineer, Robert B. Morse. The results of these preliminary studies are set forth in this paper in order that they may elicit further comment and study from other investigators. The findings here reported seem to be of sufficient importance to warrant publication even though more experimental work is desirable before the ultimate practical significance of all of the data becomes apparent. A number of the conclusions of the writers may appear to be somewhat hypothetical, but their substantiation is possible only by the reporting of similar phenomena and empirical facts by others. The demonstration of scientific theories is limited in its scope by the availability of correlated and pertinent phenomena. Only a few of the characteristics of these interesting occurrences have been noted by the present writers. If simultaneous and confirmatory observations are suggested by our brief remarks, then much will have been accomplished in the clarification of some of the complex properties of filter sands.

Under-Water Contraction or Shrinkage of Filter Beds. An extended search of published literature on filter sands or allied subjects has failed to produce any reference to the occurrence of actual under-water surface shrinkage of filter sands. In the latter part of June, 1919, a study of the operating records of the Springfield State Hospital rapid sand filtration plant revealed the fact that during the week of May 6 to 13, 1919, the B. Coli contents of both filter bed effluents became excessive and remained higher than previously, up to the time of this writing (January, 1920). This sudden rise in bacterial content was not accompanied by any modification in method of operation or by any apparent change in applied raw water. The abruptness of the change is indicated by the bacterial data shown in Table I. The accuracy of the analytical findings is attested by the fact that the same water after chlorination revealed no similar rise in B Coli content.

TABLE I. B. COLI PRESUMPTIVE TESTS IN FILTER EFFLUENT SAMPLES OF SPRINGFIELD STATE HOSPITAL RAPID SAND FILTRATION PLANT—1919

Date	B. Coli per 100 c.c. Filter 1	Filter 2	Date	B. Coli per 100 c.c. Filter 1	Filter 2
Jan. 28	0	0	July 15	35	5
Feb. 4	0	0	22	2,400+	231
18	0	No record	29	35	35
Mar. 4	0	0	Aug. 5	2	0
11	0	0	12	231	20
18	0	2	19	35	2,400+
25	0	0	26†	2	2
April 1	9	0	Sept. 2	5	0
8	0	0	9	2	20
13	0	0	16	0	0
22	2	0	23	2	0
29	0	0	30	0	0
May 6*	0	0	Oct. 7	0	0
13	2,400+	35	21	2	5
20	231	9	28	20	35
27	231	231	Nov. 4	231	35
June 3	35	35	12	0	0
10	231	231	18	0	2
17	2,400+	231	Dec. 9	2	2
24	35	35	16	0	2
July 1	15	15	23	15	5
8	5	9			

* May 6-13—New sand placed, less on filter 2 than on filter 1.

† Aug. 23—Five inches of top sand removed from filter 2. Although no directions were given to remove sand from No. 1 measurements disclosed a loss in depth of sand of from 3 to 4 in. on No. 1 following Aug. 23.

An inspection of the two filter beds during June and succeeding months disclosed the following facts: The entire sand bed in each filter had drawn away on all four sides from the concrete walls, to distances ranging from ½ to 1½ in. in width, and to depths of sand varying in filter 1 from 4 to 12 in. and in filter 2 from 2 to 6 in. This phenomenon of shrinkage existed under water and was apparent by drawing off the water to a depth of from 12 to 18 in. above the sand bed. The importance of the under-water contraction was immediately apparent to the observer, since the rate of filtration through the open area extending around the four sides of the bed was so much greater than through the bed proper that definite currents of water flowed with increased velocity, as shown by the carrying of alum floc down the sides instead of through the bed. The internal contracting force of the sand bed, in addition, was so great that the head of water upon the bed did not cause the sand surface to expand but simply spalled off portions of corners of the bed causing transverse cracks of great size within the bed. The intensity of this internal force was further demonstrated in the back-washing of the bed with a high velocity wash. The entire bed was lifted up by the incoming wash-water and raised without breaking, while the water gushed around the open spaces on the sides until the weight of the bed itself caused its collapse. After complete washing, the sand beds usually returned to fairly normal condition, although the existence of a circumferential crack was apparent. A number of inspections of the beds in succeeding months, while the investigation was being carried on, disclosed a continuation of the same phenomena.

The amount of the under-water shrinkage may be arrived at in the following manner: Each of the filter units is 8 by 11 ft. in surface area. With an average contraction on all four sides of 1 in. the total percentage shrinkage in surface area would be approximately 3.5. The minimum shrinkage observed was about 1.8 per cent and the maximum, with cracks of 1½ in., about 5.3 per cent. Approximately the same percentage shrinkage has been observed in a number of filter beds in another plant in Maryland. In this latter plant the filter areas are many times greater than in the Springfield plant, but the percent of shrinkage of surface is about the same. The absolute value of the percentage shrinkage, although significant, as giving the reduction of effective filtration area, is not as important as its resulting effect in permitting more than its proportionate part of the water to flow through the cracks. This latter fact should not be lost sight of in considering a quantity such as 1.8 per cent as mathematically insignificant.

An inquiry into the events preceeding the appearance of under-water contraction disclosed the fact that during the week of May 6, owing to the progressive loss of sand on the beds during previous months, the operator placed new sand on filters 1 and 2 to depths of 8 and 4 in. respectively. Some weeks previous to this time he forwarded to the Bureau of Sanitary Engineering a sample of sand for mechanical analysis, which he proposed using for replenishing the beds. This sand was condemned on account of the presence of excessive amounts of fine material and the operator was so informed. He asserted, however, that the condemned sand was not used, but that some of the left-over sand, originally used for the beds, had been placed. Samples of this left-over sand, other than that on the bed, the operator was unable to locate. The sudden appearance of shrinkage, differing in depths in the two beds roughly in accordance with the amounts of new sand placed, led us to believe that this new sand, whether the condemned or otherwise, was responsible, in a measure at least, for the phenomenon observed. The granulometric analyses of the condemned and of the top sand in place after May 13 are shown on Table II.

TABLE II. GRANULOMETRIC ANALYSES OF SPRINGFIELD STATE HOSPITAL SANDS

Source	Per Cent Passing Sieve Numbers and Retained on Next Higher Sieve 200	100	80	50	40	30	20	10
Condemned sand...	0.0	1.8	1.6	15.8	30.6	34.6	13.6	2.0
Top sand (washed)	0.0	0.0	0.2	0.6	18.0	76.6	4.2	0.4

The adhesive property of the top sand on the filter beds at Springfield was apparent physically when a handful of the sand was taken up. Ordinary moist clean filter sand, when clasped in the hand, falls apart in numerous grains when the clasping pressure is released, but the filter sands of those beds where shrinkage has been observed, under a similar release of hand pressure, retain well their ball form and adhere strongly to the rest of the mass of sand, which has a marked degree of plasticity and stickiness, foreign to sandy media of most filter beds. It is interesting to recall at this point Clark's reference in a different connection (1894 annual report of the Massachusetts State Board of Health) to the marked pasty feeling and appearance, when wet, of a white North Carolina sand of effective size of 0.20 mm. In his discussion he refers to the fact that this white sand behaved in a manner similar to cement; that when dried after saturation with water the sand grains cling together in lumps; and that the cementing of this white sand was greater than in any other examined. Although not emphasizing the significance of his observations, Clark pointed out the importance of the great cohesion of particles of some sands under favorable conditions. In the discussion to follow the reader will be able to fit Clark's observations into the general hypothesis regarding the cause or causes of under-water shrinkage.

The reader may well ask at this point why the study of the filter sands was pursued to the exclusion of other factors in the attempt to arrive at a solution of the

problem of shrinkage. The reasons for this decision appear in the fact that the sand in the Springfield instance was the *only* factor which varied during the period of transition from absence to appearance of contraction and that, in the other plant where the sand shrinkage was observed, all the operating and structural features were similar to those existent in plants showing no shrinkage, excepting that there were marked differences in the character of sands originally used in the beds. There was, in addition, no reason to consider the applied water in either of the two plants, as peculiar, since a study of the analyses and watersheds of the streams (which are 25 to 30 miles apart) disclosed nothing different, as indicated by tests now available, from other streams in the State.

Hypothesis Regarding the Cause of Under-Water Shrinkage of Filter Beds. The observation of the various conditions described above led to the formulation of hypotheses regarding the cause of causes of the shrinkage of the sand beds. A preliminary microscopic examination of a number of filter sands in comparison with the Springfield sand disclosed a characteristic film on the grains of the latter, after persistent washing, which was not apparent on other sands. This film, however, was not apparent on the sands of the beds of the other plant where shrinkage had occurred, so that the presence of a colloidal film of itself did not appear to offer sufficient proof of the unusual adhesive property of the sands under discussion. The action of the sand bed itself, however, seemed to require for explanation the following reasoning: The sand showed actual shrinkage, plasticity and cementation. These could be brought about, under the conditions, only by the existence of some internal force or adhesive property of the sand itself, which would consist in the pulling together or attracting of other sand particles. Such an internal force would have to be predicated upon an unusually high adsorptive power of the sand, aided by the cementing material or matrix, the coagulant. Since the latter is present in all plants, its mere presence would not be responsible for the shrinkage, but it would require in addition the nucleus of an active structure of a sand showing high internal interfacial attractive forces. To develop the evidence in support of the above hypotheses, it will be necessary to inquire into (1) the nature of the causes which produce in other substances shrinkage, cementation, plasticity and bonding power, (2) the variation of the adsorptive properties of different sands, and (3) the magnitude of the adsorptive force of the "shrinkage" sands in relation to that of "non-shrinkage" sands.

Shrinkage, Cementation, etc. in Substances Other than Sand. Considerable study has been devoted in past years to the causes of shrinkage, plasticity, etc. in clays. The evidence so far adduced appears to warrant the following conclusions, adapted from the studies of Ashley[1]:

(a) Clay is a mixture of granular matter and a colloid gel.

(b) The sources of the colloid matter are organic and inorganic, principally colloidal silicates and silica, less commonly alumnia and ferric oxide.

(c) Adsorption, the property colloids have of taking other substances out of solution or suspension, may be measured by the degree of removal of color from certain dyes by clays.

(d) The adsorption of a dye by clays gives an approximate measure of plasticity.

(e) The air shrinkage of clays varies with the amount of colloids present in a clay, as measured by the dye adsorption. This condition is illustrated graphically in Fig. 1.

(f) The amount of colloids in clays, as determined by dye adsorption, roughly varies with the surface-factor or total surface areas of clays.

Ashley[1] further states that air shrinkage and plasticity are highest with high colloidal matter, while increased fineness of grain in a clay results in increased air shrinkage. Colloidal alumina, for instance, is sometimes added to clays in order to assist in the cementing properties and in the increase of air shrinkage[2]. It is clear that the ceramists have dealt so far with the phenomenon of *air* shrinkage, but it is believed that the presentation of later data will indicate that the theories underlying the air-shrinkage of materials are also concordant with the explanations of shrinkage of filter sands under water.

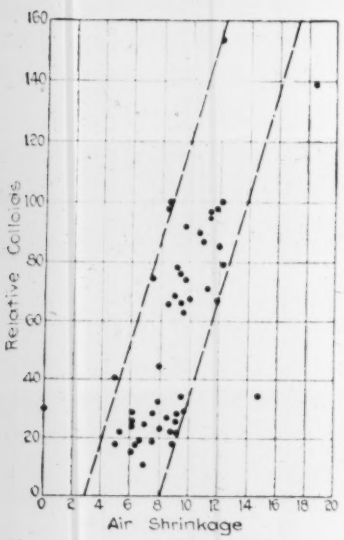


FIG. 1. RELATION BETWEEN AIR-SHRINKAGE AND COLLOID CONTENT OF CLAYS

Determined by malachite green test

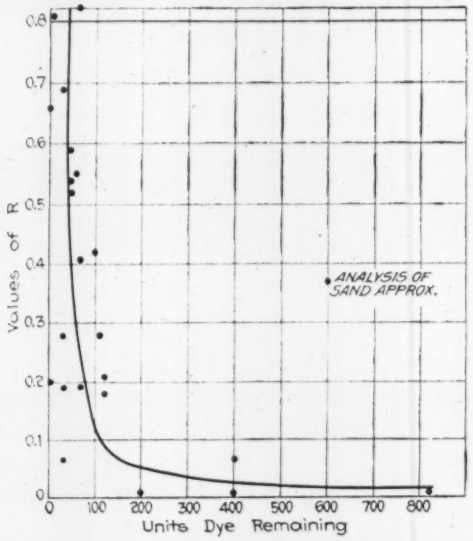


FIG. 2. RELATION BETWEEN VALUES OF "*R*" AND ADSORPTIVE CAPACITY

R = Surface area of per cent passing No. 35 sieve divided by total surface area of sample

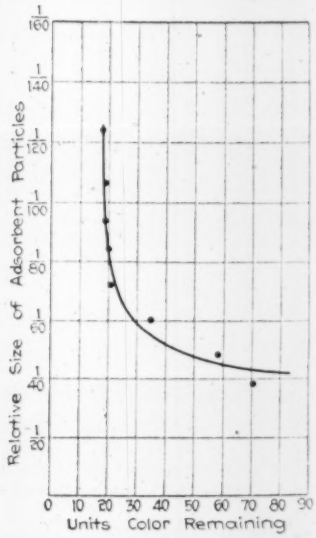


FIG. 3. RELATION BETWEEN SIZE OF PARTICLES AND ADSORPTIVE CAPACITY

Data recalculated from Bradley. See reference in text

Cushman[3] confirms Ashley's hypothesis regarding the plasticity and shrinkage of clays by his determination of the fact that mixtures of solutions of alum and sodium silicate (both colloids) increase the plasticity and shrinkage or binding power of clays. It is his opinion that both plasticity and binding power are merely manifestations of a colloid modification of matter which exists in rocks and clays. In the same way, he correlates[4] the cementing power of rock powders with the plasticity of clays and ascribes this power to the amorphous colloid structure of the particles of rock.

An interesting example of shinkage of substances in contact with a liquid is the phenomenon, scientifically termed "syneresis," or the separation of water solutions from highly hydrated substances such as silicic acid gels. Holmes, Kaufmann and Nicholas[5] describe the relatively enormous contraction of a silicic acid gel in a glass container lined with vaseline, to prevent the adherence of the gel to the glass so that the gel would be free to contract. In such contraction the gel simply squeezed out a volume of liquid equal to the decrease in volume of the gel. That this internal contracting force is dynamically powerful is indicated by the statement of Holmes et al[5] that "a paper-thin glass bulb, unlined with vaseline, was filled with the gel mixture and on setting, the gel contracted so powerfully that the glass caved in." *This powerful contracting force was not accompanied by evaporation of any of the liquor on and in the gel,* since the glass tubes were so sealed as to prevent such evaporation. It is important to call attention at this point to the conclusion of the above authors that the degree of syneresis or contraction of spherical gels closely parallels the change in the relation of surface to volume, or that syneresis varies directly as the free surface. The significance of this observation, in this instance, as well as in the explanation of the shrinkage of clays as due to the colloids (particles of great specific surface), will be more apparent in the discussion of the problem of filter sands.

It is of value, in discussing these factors of shrinkage, to refer to another field of science where the peculiar properties of sands have occasioned much thought and experimentation. Some ten years ago, Thompson[6] discussed, before the American Society of Civil Engineers, certain peculiarities of sands which had resulted in the failure of concrete structures in which they had been used. He described the failure of mortars to harden when certain sands were used, concluded that such defective sands contained excessive vegetable organic materials, and established tentative limits for organic material above which sands should not go if they were to be free from injurious effects. This same colloidal film, as a deterrent to the development of a union between cement and sand grains, was later discussed by Freeman, Free and Gaines[7] in separate articles. Gaines further explained the failure of cements to harden with certain sands as due to the retardation of reaction by colloidal films on the sand and to "steric" or structural hindrance, whereby substances accumulate on the surface of sand, *due to adsorption,* and prevent or retard chemical action with the cement.

The Adsorptive Power of Sand Grains. In all of the discussions presented above, the explanations of various phenomena dealing with plasticity, bonding power, shrinkage, negative and positive cementation have been reduced apparently to the effect of one primary action, common to the problems of ceramics, structures, highways, and specific physical chemistry, namely, adsorptive power. This adsorptive power in turn has been predicated by different writers upon the factors of colloidal surface film and upon specific surface area or character. It appears that the same property which increases plasticity of clays, binding power of rock powders and retards formation of concrete with certain sands, may be responsible for the peculiar action of the sand beds under discussion.

What then is the adsorptive capacity of sand grains and how may it be measured? The simplest procedure which we have been able to make use of for the determination of the adsorptive power of sands consists of determining the amount of color removed from a standard dye by a definite weight of a sand. Since the character of both the dye and the sand influences the color removals, the selection of a proper coloring material is important. For our purposes, the organic dye, malachite green, was chosen, since it had already been used successfully by Ashley[1] for similar purposes and since it is a basic dye. The basic dyes in general are electropositive while sand has a negative charge, so that malachite green would serve as an effective reagent for measuring comparative adsorption. Chamot also has pointed out that an excellent selective stain for gelatinous silica is malachite green. There is reason to believe that the values obtained with this dye may be correlated with the attractive forces of sands for aluminum hydroxide and, therefore, our results should reflect the action within the sand beds.

In measuring the removal of color from dyes, or the adsorbability of sands, the following standard procedure was adopted: The upper and lower amounts of sand and dye were found which would give most convenient proportions to obtain the readings between the wide ranges of results. In each experiment 100 grams of the dry sand to be tested were shaken 50 times with 250 c.c. of a 0.001 per cent distilled water solution of malachite green. This flask was then allowed to stand 24 hours to permit the fine material in the sand to settle. At the end of 24 hours 50 c.c. of the supernatant liquid were removed and matched in Nessler tubes against standard solutions of the dye to determine the strength of the residual color. The standard color was given an arbitrary value of 1000 units (the reciprocal of the percentage strength) so that the residual colors would range from 0 to 1000 units, depending upon the degree of adsorption.

The preliminary determination of relative adsorption of different sands in this manner was independent of the *causes* of such adsorption. It was our purpose, (1) to determine how much different sands vary in their adsorptive power (as measured by our arbitrary method), and (2) to attempt to discover the causes of such variations as might appear. The first sand examined in the manner described above was the Springfield sand originally condemned by this Bureau. This sand removed 994 units of color. A sample of the sand originally placed on the bed of another plant, where marked shrinkage had occurred, adsorbed 1000 units of dye, removing all trace of color. Contrasted with these two sands is a third sand, used on a bed where no shrinkage was apparent, which removed only 180 and left 820 units of dye, and a fourth sand, with no shrinkage, which removed only 400 units.

The above extreme variation in the adsoptive properties of these four sands led us to an examination of some twenty other sands from different localities, some in use on filter beds and others projected for use. The results obtained on these samples of clean dry sand are shown in Table III. It is interesting to note the extreme variations in filter sands in respect to their

TABLE III. A COMPARISON OF ADSORPTIVE CAPACITIES AND SURFACE AREAS OF VARIOUS CLEAN UNUSED FILTER SANDS

Lab. No.	Units Dye Remaining	Units Dye Adsorbed	Sq.Ft. Surface Area per 100 Lb.	*Ratio
18067	820	180	1,710	0 006
18068	600	400	1,925	0 37
18069	28	972	1,820	0 28
18084	400	600	860	0 07
18632	0	1,000	2,570	0 66
18073—I	32	968	1,830	0 19
18074—II	70	930	1,790	0 19
18075—III	36	964	1,625	0 068
18076—IV	60	940	2,530	0 552
18077—V	200	800	1,460	0 007
18078—VI	70	930	1,985	0 410
18079—VII	120	880	1,740	0 18
18080—VIII	40	960	2,245	0 52
18081—IX	110	890	1,810	0 28
18083	40	960	2,540	0 59
18360—XV	0	1,000	1,830	0 20
18361—XVI	400	600	1,560	0 007
18362—XVII	40	960	2,160	0 54
18363—XVIII	100	900	2,125	0 42
18364—XIX	30	970	2,600	0 69
18678	120	880	1,475	0 21
18061	6	994	3,325	0 84
18739	70	930	3,280	0 91

* Ratio (R) of surface area of per cent passing No. 35 sieve to surface area of total sample

adsorbability. A great proportion of those samples showing high adsorption in Table III have not been placed in filters so that their actual shrinkage factor is not available for discussion. It is highly pertinent, however, to point out that the two sands, taken from entirely different sources and used in two widely separated plants, which show peculiar shrinkage also show the highest adsorptive capacity of any of the samples tested. It is possible at least that the explanation of the shrinkage phenomenon lies in this property.

The Possible Causes of Variation in Adsorptive Power. The data in Table III answer the first of our questions regarding filter sands, namely, what is the quantitative variation in adsorptive power of sands. There still remains the problem of determining the factor or factors which predetermine the relative adsorption of dyestuffs by substances. Hatschek[9] states that "the amount of a substance adsorbed, other things being equal, is proportional to the active surface of the adsorbent." In other words, we shall expect that the greater the specific surface of a sand the greater will be its adsorptive capacity. The validity of this conclusion may be tested by comparing the sizes of different sands with their adsorptive capacities. A study of the surface areas of sands, clays and rock powders of spherical and cubical shape by Purdy[10] and many years later by Edwards[11] and Young[12] has shown that the surface areas of the particles per unit volume vary inversely as the diameters of the particles. In other words, a particle of sand having a diameter of 0.2 mm. has a surface factor of 5, while one having a diameter of 0.8 mm. has a relative surface factor of 1.25. Young has developed the method of calculating surface areas to a further degree by the use of the granulometric analysis of sands. This method, a description of which would require too much space and which may be found in the aforementioned discussion, has been adopted by the present writers for the calculation of the surface areas in square feet per 100 lb. of sand, from the mechanical analysis of the sands used in this study. Young's relative values for surface areas do not differ very much from those obtained by Purdy and other investigators.

The values obtained in the calculations of total surface areas (shown in Table III) indicate that in the sands studied the total surface areas per 100 lb. vary from 860 to 3,325 sq.ft. The variations in *character* of surface area are, of course, not taken into account in the method described. For instance, sample 18,084 shows a surface area of only 860 sq.ft. per 100 lb., but also has a relatively high adsorptive capacity. Sample 18,084 happens to be a coal filter medium of great effective size and more than usual specific surface on account of its slab-shaped irregular surface. It is apparent, however, from a study of Table III that no great correlation exists between *total* surface areas and adsorptive capacities. But it is important to remember that this correlation probably is masked due to the inclusion in the above figures of the areas of large particles which show only slight adsorption.

A better measure of the effect of specific area upon adsorption, therefore, should be a comparison between adsorptions and the ratios (R) of the surface areas of the finer grains in a sample to the total area of the sample. This last ratio (R) would indicate whether two total surface areas, both large, are made up entirely of large particles or, what is most important, of effective adsorptive small particles. When these ratios (R) are calculated by taking the ratio of the area of all the particles passing sieve 35 to the total area of all the particles in the sample, we get a different picture of the situation. In Fig. 2 the values of R have been plotted against "units of dye remaining." It is apparent from these results that a definite correlation exists between proportion of fine material in the sand and adsorptive power. From the meager data available it is difficult to indicate the exact value of R at which the flexure in the curve takes place, but it is clear that the adsorptive power decreases gradually with sharp decrease in values of R up to a critical value of R where adsorbability changes very rapidly. The above correlation between the relative area of sand grain and adsorptive capacity may be further demonstrated by the evaluation of the coefficient of correlation[13] between the actual percentage of material passing a No. 35 sieve and the number of units of dye remaining. The coefficient of correlation measures mathematically the degree of relationship between two variables. Its numerical value may lie between —1 and +1, denoting perfect inverse and direct correlation respectively. In the case under discussion, the coefficient of correlation was found to be about —0.5, denoting good or high inverse correlation between residual dye and proportion of fine sand. (This same finding has been reported in different connections by Dreaper and Davis[14] and by Bradley[14A], whose results are shown in Fig. 3.) The value of —0.5 may be considered excellent in view of the wide variation in character of the sands tested and of the rough methods of measurement of the factors correlated. It appears from the preceding discussion that the usual "effective size" values still play an important part as a diagnostic index of this additional characteristic of sand, although we are not prepared to state as yet what critical values of "effective size" should be considered as marking the transition point between shrinkage and non-shrinkage of sand beds. Such a critical value must be determined

by an analysis of empirical data accumulated from different plants and by independent observers.

In this connection, it is interesting to point out that these six filter beds in two different plants which show the greatest shrinkage of 38 beds studied (all of which contracted more or less in comparison with numerous other non-shrinkage beds) originally contained sands showing the following recorded characteristics:

Effective Size	0.31	0.33	0.27	0.27	0.33	0.23
Uniformity coefficient	1.98	1.79	2.04	2.13	1.77	1.80

The importance of this observation is apparent when it is mentioned that, after two to four years operation (in the five older beds), examination of the beds showed upper layers of sand, varying to depths of 3 to 4 in., of sizes finer than 0.28 mm.

Although the importance of size and large specific area have been stressed in the above discussion, it must be pointed out that high adsorption may occur with materials such as sand, even when the *apparent* size (by granulometric analysis) is great and the specific area per unit weight *apparently* low. We use these terms advisedly, since adsorption is a function of large *internal* active surface which often is not indicated by the usual mechanical analysis. Three striking examples of this active internal surface are mentioned briefly to illustrate the danger of pinning all our faith to the "effective size" only. One of these, the coal filter medium, has been referred to earlier in the discussion. This material showed adsorption excessive in proportion to its effective size (0.8 mm.). A second example is that of a standard Ottawa sand of about 0.5 mm. effective size, 100 grams of which adsorbed 988 units of dye, comparable with the adsorption of a normal sand of effective size of about 0.25 mm.

The importance of great internal surface in determining adsorptive capacity is brought out most clearly by an experiment carried out upon a synthetic silicon-dioxide, supplied through the courtesy of Professor Patrick of the Department of Physical Chemistry of the Johns Hopkins University. The material used by us has an effective size of over 0.5 mm. but is characterized by an exceedingly great internal surface consisting of minute capillary tubules which have the power of adsorbing vast quantities of gases and liquids to approximately 30 to 40 per cent of its own weight. Eighteen grams of this silicon dioxide adsorb completely 1,000 units of the dye used in our experiments. In other words, 18 grams of this material are equivalent in adsorptive capacity to 100 grams of the sand which showed excessive shrinkage and, incidentally, low effective size. The possible practical significance of the above relationship will be pointed out later. It need be emphasized only, at this point, that much caution should be used in reasoning from *apparent* size of grain to adsorptive capacity.

The Colloidal Film on Sand Grains and Organic Impurities in Sands. It is not believed that the mere presence or absence of a colloidal organic film on sand grains plays an important part in predetermining either their adsorption or shrinkage, since no definite correlation could be established between the presence of film or organic content and adsorptive capacity or cementation. The organic contents were determined in two ways, by the so-called Abrams-Harder test[15], [16] and by the determination of oxidizable matter in sands by ignition. (The Abrams-Harder test consists of treating a known weight of sand with a dilute solution of sodium hydroxide and observing the resultant color after the mixture has been allowed to stand 24 hours. The intensity of color is an approximate measure of the amount of organic impurities present.) It was found, in the case of one of the sands which showed high adsorption and excessive shrinkage, that the organic content by both of the above tests was excessive and this was confirmed by the presence of a heavy collodial film on the grains, which was easily to be detected under the microscope. The same thing, however, did not hold with respect to the other high-shrinkage sand and similar discrepancies appeared in other sands. (That cementation of particles is possible without the presence of organic film is further demonstrated by the work of Jensen[16a] on the phenomenon of "plowsole".) Although the Abrams-Harder test for organic impurities in sands may not disclose any real information regarding adsorption and shrinkage, yet its simplicity should recommend it highly to the water-works investigator for further correlated study.

Concluding Observations on Adsorption by Sand Grains. It is postulated frequently in textbooks and in other discussions of water filtration problems that it is desirable to use filter sands of high adsorptive power. Chamot[17], for instance, states in one of his interesting addresses that "the sanitary engineer in writing his specifications for sand beds ought to be able to include details looking toward the use of a filter medium of high adsorptive power." It is pertinent to ask, in the light of the possible correlation between high adsorption and shrinkage, with its attendant evils, whether the gain by the use of high adsorptive sands is not offset by the objectionable features? If high adsorptive capacity results in cementation, shrinkage, plasticity and cracking effects, is it desirable to specify high adsorption. Considerable remains to be done, of course, in the way of demonstrating the action of adsorptive sands in rapid sand filtration plants under varying conditions before the above question may be definitely answered. Preliminary findings, however, indicate that under the conditions peculiar to rapid sand filtration plants, high adsorption would not be entirely a desirable attribute of the sand medium.

The interesting relation between fineness of sand grain and adsorptive power also leads to the conclusion that, in those beds initially supplied with a proportion of fine sand, the finer particles do not appear to be washed out after years of use. It is stated often that a medium containing fine material may be used on a rapid sand bed, since successive washing will eliminate the finer grains. It is not believed that this gradual elimination actually takes place, for it has been found in our study of the 34 filter beds, showing varying degrees of actual shrinkage, that the bed showed the highest shrinkage which had had originally a fair quota of the finest sand. Even though this particular bed had been in use over several years, the objectionable effects of the fine material have not yet been removed. This would seem to indicate that the highly adsorptive sand was still in place. The possible reason for its persistency may well have its origin in the fact that, owing to its high adsorptive capacity, it seizes floc and other material and, hence, when backwashed, acts as particles of similar and large size owing to its accumulation of foreign substances.

It is suggested also that the existence of patches of highly adsorptive sand, of either small size or unusually

active surface, may be responsible for the formation of the objectionable and tenacious mud balls with which filter operators frequently are troubled. It is conceivable that such nuclei in a bed might react in such manner as to produce the above mentioned phenomenon, but here, too, experimentation is still much behind the practical problem. Attributing the formation of mud balls to faulty design of wash water systems does not explain the frequent development of mud balls where washing arrangements are apparently excellent.

In passing, mention should be made of a field of filtration where the highly adsorptive sand may and should possibly be specified. In the drifting-sand process of water filtration, at least a part of the purification is effected through the adsorptive power of sand grains. We are not aware, however, that this knowledge has led to any newer specification for sand grains to be used in the drifting portion of the bed. It would seem that such sands would be chosen for their increased adsorptive capacity over normal sands, and it might be desirable even to try experimentally some such medium as the synthetic silicon-dioxide already mentioned in this paper. Where the desideratum is almost entirely attractive and retentive capacity, as in the drifting-sand medium, it may be economy to purchase a more expensive, but a more powerfully activated, medium.

In conclusion, the writers wish to state that the comments and observations here set forth upon the adsorptive and colloidal properties of sands and their practical importance should be received as preliminary inquiries into a complex field, rather than as final and definite conclusions supported by a paucity of data. The phenomenon of under-water shrinkage of sand beds no doubt is intimately influenced by a series of factors, in which coagulant, algæ, characteristics of applied water, etc., have considerable importance, but it is our belief that the nature of the filter medium itself plays a predominating part or else the contraction phenomenon should be common to all plants. If this discussion should bring forth more experimentation upon the complex problems of the mechanism of filtration and the function of the sand medium therein, it will have served its purpose completely.

The writers take much pleasure in publicly thanking for their valuable aid in the preparation of the above discussion the following persons: Miss Burroughs, assistant chemist, Maryland State Department of Health, who is responsible for the analytical determinations of the adsorptive capacities of the different sands; Professor Patrick, of the department of physical chemistry of the Johns Hopkins University, who discussed with the writers their hypotheses and who suggested the experiment with the synthetic silicon dioxide; Mr. Bayliss, chemist of the Baltimore city water filtration plant, whose criticism of the final discussion was most helpful; Mr. Hannan, chemist of the Toronto filtration plant, who discussed in detail the final paper and offered a number of valuable suggestions as to context and additions to confirmatory references; Mr. Howard, bacteriologist of the Toronto filtration plant, who read and criticized the final manuscript.

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Grade-Crossing Removal Progress at Syracuse

Removal of the railway tracks at Syracuse, N. Y., and the utilization of the old Erie Canal bed there has been a project under consideration for a number of years, but it has been held up by general delay due to the war. The acquisition of the canal bank through the city is an essential preliminary to the grade-crossing elimination project. The Common Council in 1919 declared the intention of the City to take over all of the canal lands in the city which are to be abandoned and to make application to the Land Board pursuant to the provision of the so-called Walters Act of 1916. This act has recently been amended so as to enable the City to dispose of such canal lands as it might acquire and not use for public purpose. The city charter provided that such property shall not be disposed of at public sale, a method which it is thought would be disadvantageous in this case. The amendment which has been signed recently by Governor Smith provides that the land may be disposed of at "public or private sale." The Land Board has caused an appraisal of the land to be made, though the valuation has not yet been made public. It is probable that the next step will be a request from the city to the Canal Board to abandon formally the canal land. This being done, the City has to take the necessary steps within four months to raise the money to acquire the land. The City, it is understood, is still definitely in favor of the so-called Arnold scheme for grade-crossing removal as reported in 1915. In this scheme the old bed of the Erie Canal is utilized extensively to provide a depressed way through the city for the railroad tracks. While it is locally reported that the railroad is in opposition to this scheme, no definite action can be taken until the City presents to the railroad company a tentative contract based on the depression scheme. It is expected that this will be undertaken in the not distant future.

The British Government's Huge Housing Scheme

BY
E. J. McHenry
EDITOR ENGINEERING NEWS-RECORD

REFERENCE has been made in the columns of *Engineering News-Record* to the restriction of "luxury construction" in England in order to allow the building of dwellings to proceed. What has been said, however, conveys no adequate impression of the magnitude of the housing enterprise which is being promoted and subsidized by the Imperial Government.

BRICK AND STONE DWELLINGS OF HOUSING SCHEME IN EDINBURGH

To the week ended May 22, plans had been approved by the Ministry of Health *for no less than 184,000 houses*. These approvals involve 3,700 separate schemes, covering 48,000 acres of land. Tenders had then been approved for 102,000 houses, and the chief architect of the Ministry, Mr. Raymond Unwin, estimated that between 30,000 and 40,000 houses were then under way. None of these figures include houses being built by private owners or speculative builders, but only those included in municipal housing projects. By "house" is meant not necessarily a detached single-family dwelling, but the apartment for one family. A four-family building, therefore, would be rated in the above figures as four houses.

There are various points of interest for American readers: While each building is a simple construction problem, the planning of the new villages and subdivisions is a city-planning or city-engineering problem of great total magnitude; the building of many small structures in a given area offers opportunity for skillful construction organization; the work is largely in the hands of engineers—in fact, some of the city engineers serve also as directors of housing; the scheme is a state financing plan that goes far beyond what has hitherto been considered the province of government either in Europe or in America; and, lastly, the Government deems the housing situation so urgent that it is curtailing unnecessary interfering construction.

Cities and villages in order to get the Government's subsidy must agree for 60 years to raise for housing one penny in the pound Sterling of taxable value. The taxable value, by the way, is not the market value of the property, but the annual rental thereof. Against the annual and fixed charges the cities will credit the rents and the proceeds of the one-penny tax. Whatever loss is shown will be paid by the Government.

The Government does not lend money to the larger communities for building operations, but since it has guaranteed to pay the losses, the bonds virtually are

guaranteed and the large cities have had no difficulty in disposing of housing bonds bearing 6 per cent interest. The smaller communities will be permitted to borrow from the Government.

In addition to this scheme, outright grants are made to individual owners and to speculative builders who put up houses having 1,400 sq.ft. of floor space or less. These grants, which are in cash, varied from £130 to £160 per house, depending on size, but these limiting figures have recently been increased to £230 and £260 respectively. In other words, if one builds a modest house, the Government will contribute from $1,150 to $1,300 toward the cost. The buildings, like those in the municipal schemes, must be of permanent construction and the plans must be approved by the Ministry of Health.

An additional feature of the housing scheme is that "public utility societies," which engage in building and limit their profits to 6 per cent per annum, can borrow 75 per cent of their capital from the Government and in addition are given a grant of 50 per cent of their capital charges for 7 years and 30 per cent for the ensuing 43 years.

While the communities are coming into the scheme in large numbers, the individual, whether speculative builder or owner, is not. He fears that the inevitable drop in values will more than wipe out the Government's subsidy. Building costs now are more than twice what they were before the war.

Obviously, the Government is likely to incur a heavy expenditure under the plan. Already rentals are being fixed which show a heavy annual loss, such rentals necessarily being based on those of nearly pre-war buildings. The estimates of the direct grants and the losses run into hundreds of millions of pounds, and the financial features have been widely condemned. Those who disapprove them admit generally that they are unable to suggest any better scheme. It is admitted that the housing situation is very serious and that the Government must take it in hand. The trouble is traceable not merely to discontinuance of house construction during the war, but to the cessation of speculative building after the passage of a law in 1910, fathered by Lloyd George, taxing away the "unearned increment" in property values. Even before the war the Government had been lending money on housing schemes but had not granted subsidies. One of the remedies proposed for the situation is the repeal of the act of 1910, but that proposal seems to find little favor with the powers that be.

The character of house contemplated by the authorities is indicated by the limitation of grants to houses having 1,400 sq.ft. of floor area or less, with a maximum of two living rooms (usually a combined living and dining room and a parlor) and four bedrooms. A bathroom and a scullery, or small kitchen, are always included but are not counted as "rooms" when, say, a six-room house is referred to.

The average price of the tenders to date I was not able to learn, but for the first 30,000 houses was £796. These were not all of the maximum size; in fact, they are more likely to be of the one-living-room- three-bedroom type. These figures include the cost of the building and the necessary land, paving and sewers, but not of the paying utilities such as the water, gas and electric mains. In general it is expected that the cost will be about £1,000 per house.

Some of the schemes, notably one at London under the London County Council, run into tremendous figures, involving the building of whole communities. On these the contractors will use much plant and big organizations. In practically all cases, on both large and small projects, the contractors bid unit figures which are used as a base from which actual cost figures, adjusted to the rise and fall of wages and material prices, are computed. In other words, the contractor does not carry the risk incident to rising prices. In one case, a large operation, the contractors were asked to bid their total profit, that profit, according to the agreement, to be a fixed sum.

The restrictive power reposed in the Ministry of Health has been delegated to local committees made up of city officials and of men familiar with business and building conditions and the local needs. So far, the restrictive power has been invoked against such proposed work as moving-picture theaters, and the building and alteration of retail stores.

The work actually done this year will be far less than either the Government or the communities desire. Transportation and labor will be the limiting factors. Materials are short, too, but they can be supplied, it is believed, as rapidly as they can be transported and put into the jobs.

Chief interest in the scheme just at present lies in the financial experiment involved. For the outcome we shall have to wait for years. For the American engineer and contractor, though, there may be much of interest before long if the bigger schemes are carried out with labor-saving plant and rapid-construction organizations. In the town-planning schemes there will be interesting features. For example, on one of the developments the width for interior streets is only 30 ft. with carriageways of 13 ft. The houses, of course, must be set back from the property line. In fact, for three-story buildings (three stories being maximum height) the open-ground area for each plot must be twice the building area; for a two-story dwelling, one and three-quarter times the building area; and for a single-family dwelling, presumably two stories, one and one-half times the building area.

Commenting on the labor conditions, one director of housing recently remarked: "The working people who keep shouting for houses are the very ones who will not help us get them." His testimony agreed with that of others. The fact that they were building houses for their own use had not secured increased production. In one city the labor unions have proposed to take a contract to build a group of houses, but to date the plan has not materialized. The hitch came when the unions were asked, like any other contractor, to agree to a base price. They began to think twice when they could not secure a force-account contract—the community to foot the bill no matter what the cost might be.

Glasgow, May 28.

Proposed Municipal Milk Distributing Plant

The establishment of a milk distributing plant to be operated by the village is under consideration at Saranac Lake, N. Y. A project for both the production and distribution of milk by the city of Jamestown, N. Y., was kept before the people of that city by its Mayor for some time a few years ago.

Uniform Pressure on Building Foundation Beds

Review of Practice and Code Provisions, with Numerical Comparisons for Typical Office Buildings, Followed by a Recommended Specification

By R. Fleming
American Bridge Co., New York City

The failure of the foundations of a particular building led the writer into a review of foundations of buildings in general, and the problem of obtaining uniformity of pressure distribution in particular. Because this latter part of the inquiry revealed such wide differences of practice as to indicate a very unsettled state of engineering opinion, the review is summarized here as a suggestion for further discussion of the problem. A specification formulated by the writer as the result of his study is appended.

Early Chicago Practice.—For knowledge on the subject we naturally turn to Chicago. It is there that notable pioneer work was done and it is there that the art of coustructing foundations on compressible soils has been brought to its highest development. The method of having each column and wall in a building rest on its own foundation, independent of all others, was first advocated by Frederick Baumann, a Chicago architect. His pamphlet, "The Method of Constructing Foundations on Isolated Piers," published in 1872,[1] introduced a new era in foundation construction. The many-storied iron skeleton building on spread foundations came into being a few years later. Much of the early literature—articles by Jenney, Purdy and others—can still be read with interest and profit.

It is to be hoped that an engineer with the historic sense will some day collate the literature on the foundations of Chicago buildings and put forth his efforts in a book. A second volume of modest size, "Foundations after Twenty Years," would also be of great value. Have the foundations of . . . settled evenly? Is there still a slope in the sidewalk adjoining the . . . building? How has the adjustable column support of the Marquette building worked? Engineers outside of Chicago are at a disadvantage in obtaining answers to these questions.

It has been emphasized again and again that in foundation work settlement should be uniform. On compressible soils settlement comes slowly, but none the less surely, and if this settlement is not uniform, or nearly so, there will be cracks *somewhere*.

A great deal of study has been given to the foundations of high buildings and to those with unusual features. Difficult foundation problems have been solved successfully. Less consideration has been given to comparatively low buildings—say ten stories and under. What follows is written mainly with this class in mind.

Allowed Bearing Pressure.—As repeatedly stated three factors entering into foundation design are: The bearing capacity of the soil, the amount of the load, and the distribution of the load. To these should be added a fourth—the building code. It is often difficult to design foundations economically and at the same time in accordance with loading requirements of the building code.

[1]This pamphlet, revised by G. T. Powell and entitled "The Art of Preparing Foundations with Particular Illustrations of the Method of Isolated Piers as Followed in Chicago," is published as an appendix to Powell's "Foundations and Foundation Walls." 1879. 1884. 1889.

The maximum bearing capacities of soils specified in municipal building codes are usually 1 ton per sq. ft. on "soft wet clay," 2 tons on "ordinary clay," 3 tons on "dry clay" and 4 tons on "hard clay." Philadelphia and some other codes allow 6 tons on gravel. Milwaukee allows ½ ton per sq.ft. on quicksand and alluvial soils, while in Memphis 1½ tons is permitted. A number of codes are quite explicit in forbidding foundations to rest on made ground. In Chicago a wet clay underlies a stratum of hard clay or clay and sand, an unfavorable condition for heavy loads; the maximum bearing pressures, conditioned on the upper stratum being 15 ft. thick, are as follows: If of pure clay without admixture of any foreign substance other than gravel, 3,500 lb. per sq.ft.; if of pure clay, dry and thoroughly compressed, 4,500 lb.; if of firm sand without admixture of clay, loam or other foreign substance, 5,000 lb.; if of a mixture of clay and sand, 3,000 lb. per sq.ft.

Bearing Tests Desirable.—Too much reliance should not be placed upon bearing pressures allowed by the average building code. The values given are often copied from other codes, and not always with good judgment. It should also be remembered that "not more than" does not mean "as much as." Tests should be made: The code of New Orleans does not allow more than 1,400 lb. per sq.ft. on soil, the whole city being on an alluvial formation, but a few years ago the builders of a steel water tower just within the city limits decided after making tests that 650 lb. was the maximum pressure permissible at that particular site.

The Omaha code does not allow a greater pressure than 3,000 lb. per sq.ft. without preliminary borings being made under the direction of the building inspector. The Sioux City code limits the pressure for spread foundations to 2,500 lb. per sq.ft. unless "carefully conducted investigations and tests indicate that the soil will safely carry a greater load." The Toledo code specifiies, "It shall be ascertained that there is no underlying stratum of inferior material."

It is surprising how the matter of soil-testing is neglected. A slight expenditure of time and money would enable the designer to use accurate knowledge instead of guesswork. Caution should be exercised in making use of published tests. Wrong inferences may be drawn unless the conditions under which the tests were made are given. The Omaha code does not allow foundations to be proportioned for greater than one-half of the test load, "where such test load has not exceeded the satisfactory carrying capacity of the soil in question." The regulations governing tests in the Borough of Manhattan, New York, specify, "The accepted safe load shall not exceed two-thirds of the final test load." No intelligent comparison of results can be made, however, without a knowledge of the apparatus used and the regulations governing the tests.

What Are The Loads?—The loads coming upon the foundations of a building through the basement col-

umns are the dead load, the live load and the wind load. The dead load includes the steel frame, the walls and the floor construction, the weights of which can be determined with a fair degree of accuracy. The live and wind loads are usually prescribed by a building code. In this respect the codes are at hopeless variance with one another. For office buildings the range of live load for floors is from 40 lb. per sq.ft. (Milwaukee and Fort Worth) to 100 lb. (Boston and neighboring cities.)

Tables I and II are based on floor panels 18 x 18 ft., story heights 12 ft., exterior walls 12 in. thick carried by lintels at each floor above the first, 30 per cent of wall surface filled with glazing, weight of floor construction 70 lb. per sq.ft., roof construction 50 lb. per sq. ft. No wind loads are included. In each table "Col. 1" is a corner column, "Col. 2" an intermediate exterior column and "Col. 3" an interior column.

TABLE I. BASEMENT COLUMN LOADS FOR THREE TYPICAL OFFICE BUILDINGS

Stories	Column No.	Dead	Live	Total	Per Cent	Equivalent
6	1	138.0	35.9	173.9	20.6	65.6
	2	176.1	71.9	248.0	29.0	65.6
	3	152.3	143.8	296.1	48.5	65.6
8	1	189.4	44.2	233.6	18.9	61.9
	2	238.8	88.3	327.1	27.0	61.9
	3	197.6	176.6	374.2	47.2	61.9
10	1	240.7	51.1	291.8	17.5	58.1
	2	301.5	102.2	403.7	25.3	58.1
	3	243.0	204.5	447.5	45.7	58.1

Loads under "Dead," "Live," and "Total" are given in thousands of pounds.
Under "per cent" is given the per cent of total load calculated as live load.
Under "Equivalent" is given the average floor live load, in pounds per square foot over entire floor area carried by the column.

Table I, computed for typical average office-building conditions, follows the floor live load specified in 60 building codes which require for columns 75 lb. per sq.ft. on the top floor, 75 lb. less 5 per cent for the floor below the top floor, 75 lb. less 10 per cent on the next lower floor, the reduction increasing by increments of 5 per cent on each successive floor until 50 per cent is reached, which reduced load is used for all floors below. Roof live load is taken at 50 lb. per sq.ft. (These provisions are those of the former New York code.)

Table II follows the live loads of the present New York, Chicago and Boston codes. The New York code specifies 60 lb. per sq. ft. for floor load and 40 lb. for roof load; the reduction formula for column loads is the same as used in Table I. The Chicago code specifies 50 lb. live load for floors and 25 lb. for roof; for columns live loads are reduced to 85 per cent for the top floor and are 5 per cent less for each succeeding floor until 50 per cent is reached, which reduced load is used for each of the remaining floors. The Boston code specifies 100 lb. live load for floors and 40 lb. for roof; for columns in office buildings it allows a reduction of 15 per cent of the total live load where 2 floors are carried; of 20 per cent where 3 floors are carried; of 25 per cent for 4 floors, etc., the reduction increasing 5 per cent for each successive floor until 50 per cent is reached, which is used for 9 or more floors.

The dead loads for Table II would be the same as for Table I and are not repeated.

Computing Foundation Loads.—Building codes differ greatly in provisions for determining the area of foundation beds. The former New York code has been so widely used as a model in the compilation of other codes that it will be quoted:

The loads exerting pressure under the footings of foundations in buildings more than three stories in height are to be computed as follows: For warehouses and factories they are to be the full dead load and the full live load established by section 130 of this code. In stores and buildings for light manufacturing purposes they are to be the full dead load and 75 per cent of the live load established by section 130 of this code.

In churches, school-houses and places of public amusement or assembly, they are to be the full dead load and 75 per cent of the live load established by section 130 of this code.

In other buildings, hotels, dwellings, apartment houses, tenement houses, lodging houses and stables they are to be the full dead load and 60 per cent of the live load established by section 130 of this code.

Footings will be so designed that the loads will be as nearly uniform as possible and not in excess of the safe bearing capacity of the soil.

With variations in the percentage of live load these provisions are embodied in the building codes of a large number of cities. For office buildings 60 per cent is used in Atlanta, Detroit, Jersey City, Newark, Paterson; 40 per cent in Evansville, Memphis, St. Paul; 25 per cent in Baltimore; 20 per cent in New Orleans.

The present New York code specifies:

For the loads exerting pressure under the footings of foundations the full dead loads and the figured live loads on the lowest tier of columns, piers or walls shall be taken.

Footings shall be so designed that the loads they sustain per unit of area shall be as nearly uniform as possible and within the bearing capacities of soils established by this article, and that the stresses in the materials shall not exceed those fixed by this chapter. In proportioning the

TABLE II. BASEMENT COLUMN LOADS OF OFFICE BUILDINGS UNDER THREE DIFFERENT BUILDING CODES

		New York				Chicago				Boston			
Stories	Column No.	Live	Total	Per Cent	Equivalent	Live	Total	Per Cent	Equivalent	Live	Total	Per Cent	Equivalent
6	1	28.7	166.7	17.2	52.5	19.6	157.6	12.4	36.2	34.8	172.8	20.1	65.0
	2	57.5	233.6	24.6	52.5	39.3	215.4	18.2	36.2	69.7	245.8	28.4	65.0
	3	115.0	267.3	43.1	52.5	78.6	230.9	34.0	36.2	139.3	291.6	47.1	65.0
8	1	35.4	224.8	15.7	49.5	23.9	213.3	11.2	33.7	38.9	228.3	17.0	55.0
	2	70.6	309.4	22.8	49.5	47.8	285.6	16.7	33.7	77.8	316.6	24.6	55.0
	3	141.3	338.9	41.8	49.5	95.6	293.2	32.7	33.7	155.6	353.2	44.1	55.0
10	1	40.9	281.6	14.5	46.5	28.0	268.7	10.4	32.0	43.7	284.4	15.4	50.0
	2	81.8	383.3	21.3	46.5	55.9	357.4	15.6	32.0	87.5	389.0	22.5	50.0
	3	163.7	406.7	40.2	46.5	111.8	354.8	31.5	32.0	175.0	418.0	41.9	50.0
20	1	65.2	562.6	11.6	38.2	48.2	545.6	8.8	28.5	Boston Building Code prohibits buildings more than 125 feet in height.			
	2	130.4	745.3	17.5	38.2	95.4	711.3	13.5	28.5				
	3	260.8	730.6	35.7	38.2	192.8	662.6	29.1	28.5				

Loads under "Live" and "Total" are given in thousands of pounds. Under "Per Cent" is given the percentage of total load calculated as live load. Under "Equivalent" is given the average floor live load in pounds per square foot over entire floor area carried by the column.

NOTE—Since the above was written the Boston Building Law has been revised. The specified live load for office floor is now 75 lb. per sq. ft. However, several New England cities still follow the 100 lbs. of the former Boston code.

areas of footings for any building the dead load alone shall be considered, provided, however, that in no case shall the pressure under the footings, as determined in subdivision 5 of this section, exceed the safe load on the soil established by this article.

These provisions are in accordance with Schneider's "General Specifications for Structural Work of Buildings."

The Chicago code specifies:

The entire dead load and the percentage of live load on basement columns, piers and walls shall be taken in determining the stress in foundations.

In addition to the entire dead loads, not less than the following proportion of the percentage of live load on the basement columns, piers and walls shall be taken in determining the number of piles for pile foundations and the area of concrete caissons.

(The proportion ranges from 75 per cent for warehouses and stores to 25 per cent for churches, theatres and schoolhouses. For office buildings it is 50 per cent.) The first paragraph refers to the foundations themselves and not to the soil. The second paragraph really refers to concrete caissons, it being the Chicago custom to include the whole live load in determining the strength of piling. For spread foundations it is left to the architect or engineer to determine the amount of live load to be used to give uniform settlement throughout. One reason for this is that the nature of the soil is different in the various parts of the city.

The Philadelphia code speaks of "the loads upon the soil" but does not say how they shall be computed. Similary the codes of Boston and Milwaukee are noncommittal on live-load reduction. But most good codes attempt to provide for uniformity of foundation loading in some way. Quotations from some of these follow:

Baltimore. The supporting areas of foundations and all other conditions determining their supporting power shall be proportioned to the full dead load, including the weight of the foundation itself, and in addition thereto one-half of the full live loads, as specified in Section 19 of this Article, for floors and roofs of warehouses, and one-quarter of the full live load specified for floors and roofs of other buildings.

Buffalo. Foundations shall be proportioned to the actual average loads they will have to carry in the completed and occupied building, and not to theoretical or occasional loads.

Cleveland. Each footing shall be designed to carry the full dead load plus the live load used for designing the lowest section of the column.

Indianapolis. The load carried by the soil shall be the total dead load and an average live load of not less than 10 lb. per sq.ft. of all the floor area of the building when used as an office building, lodging or tenement house and an average live load of not less than 20 lb. per sq.ft. of all the floor area, where building is used for mercantile purposes, and an average live load of not less than 60 lb. per sq.ft. of all the floor area, where such building is used as a warehouse.

Minneapolis. Foundations and their footings shall be proportioned to the actual loads they will have to sustain in the completed and loaded structure.

St. Louis. (Same as Indianapolis except for warehouses 50 per cent of the total of live load is to be used.)

South Bend. Foundations for buildings shall be proportioned to carry the entire dead load plus 50 per cent of the live load on the basement columns, piers, posts or walls. All footings and foundations for buildings shall be so designed that the loads they sustain per unit of area will be as nearly uniform as possible, and the dead load carried by the footing shall include the actual weight of the superstructure down to the bottom of the footing. In no case shall the load per square foot under any portion of any footing, due to the combined dead, live, and wind loads exceed the safe sustaining power of the soil as established by Sec. 195 of this code.

Dead load is actual load and can be determined with tolerable accuracy; it comes first upon the footing and remains there, a constant quantity. On the other hand the live load is not actual but assumed, and in many cases the assumed amount is much above any probable loading, is intermittent and does not come into action until after initial settling due to the weight of the structure has taken place. Moreover, the ratio of live to dead load varies for different columns. The problem is therefore twofold—to determine the combined dead and live load the footings are to support, and then distribute it so that settlement will be uniform.

A common method is to add for each column the dead load and the full assumed maximum live load, divide this by the allowable bearing pressure on the soil, and use the quotient for the area of the footing. If in process of time cracks appear in walls they are looked upon as incidental to building construction and to be no cause for surprise. It is true that the great majority of foundations proportioned after this manner have given no trouble. The writer has in mind a 20-story office building on a compact gravel soil in which this method was used and after a lapse of several years no evidence of unequal settlement is at hand. The method, however, is wrong in principle, and in practice has given troublesome results.

The "typical" office buildings of Table I, if on a weak soil, will settle unevenly during erection. The exterior foundations, having a greater pressure per unit of area by reason of carrying the walls, will settle more than the interior columns (which carry only the floor construction), thus leaving a lump in the interior of the building. This has happened where the final live loads brought upon the floors have been much less than those assumed. A number of codes meet the difficulty by prescribing lesser live loads for proportioning footings than those used for proportioning the lower sections of columns. (See the former New York code previously mentioned. Note also the codes of Indianapolis and St. Louis.) An objection to this method has been raised on the ground that if the reduced loadings were greatly exceeded, the allowable pressure on the soil might be exceeded sufficiently to produce further settlement of interior columns, leaving a hollow in the interior of the building.

Again, some architects and engineers choose a smaller soil load for wall columns than for interior columns. If the choice is arbitrarily made the method has little to commend it. It may be said here that foundations designed by "practical" men have often given trouble, more times, perhaps, than those designed by what some may be pleased to call "theorists."

In the early Chicago high buildings Jenney used (1884) for the footings of the Home Insurance Building the dead loads and a load of 18 lb. per sq. ft. for the average permanent load on all floors. The building was started 2½ in. above grade and when finished showed a total settlement of 2¼ in. and an extreme variation of only ¼ in. Purdy (1891) advocated that the dead loads only should be considered. He proportioned the footings of the Old Colony Building for a bearing value of 3,200 lb. per sq.ft. for dead

load, entirely neglecting the live load. The settlement 9 months after the building was finished varied from 4⅜ to 5¼ in.

Crehore, in his chapter "Modern High Buildings" in DuBois' "The Stresses in Framed Structures" (1896), recommends a method that he had used for high buildings in New York City: that foundations be proportioned according to the ratio of the dead loads. The method is that of the present New York code and the Schneider specifications (1905, 1910). To quote the latter:

> The live loads on foundations shall be assumed to be the same as for the footings of columns. The areas of the bases of the foundations shall be proportioned for the dead load only. That foundation which receives the largest ratio of live load to dead load shall be selected and proportioned for the combined dead and live loads. The dead load on this foundation shall be divided by the area thus found, and this reduced pressure per square foot shall be the permissible working pressure to be used for the dead load of all foundations.

A criticism brought against this method is that it is too conservative and requires footings larger than needed. Crehore anticipited this charge, for he wrote:

> The method is rather rigid and, perhaps, wasteful in giving larger footings under interior columns where the dead load is much less than it is in the wall columns; but if the soil is of a yielding nature the principle of proportioning the footings according to the dead load should be closely adhered to.

Tucker, "Cyclopedia of Civil Engineering," Vol. V (American School of Correspondence), in order to equalize the settlement between wall and interior columns, uses as a basis for proportioning footings the dead loads and a percentage of the live loads—25 per cent in the example given. In other respects his method is similar to that of Crehore and Schneider. Ernest McCullough has long used a method similar to that of Crehore and Schneider, but the "index footing" is that under the column having the largest percentage of dead load. This brings the method in conflict with building codes that specify the unit load on any footing from columns fully loaded must not exceed the bearing pressure on the soil, for often a considerable excess will result. In Table III according to the McCullough method the soil pressure for total dead and live loads on the footing of Col. 3 in 6-, 8- and 10-story buildings is 9250, 9210 and 9130 lb. respectively, though the assumed allowable pressure is 6,000 lb.

Moran in his chapter "Foundations," in Kidder's 'Architects and Engineers' Pocket Book," 1916, reduces to rule his method of proportioning supporting areas. He proceeds in the manner of Schneider and Crehore except that he adds "one-half the maximum probable live loads" and "one-half the maximum probable wind loads" to the dead load, for proportioning the footings. Except for its inclusion of wind load the Moran method has much to be said in its favor, but it introduces a large variable element of judgment by dealing with "maximum probable" loading.

Objection to all these methods may be raised because of the wide difference in the live loads used in proportioning the footings and those in the columns directly above them. If, as Moran thinks, the probable maximum live load for an office building is an average of 10 lb. per sq.ft. over the entire floor area, the live load coming upon the footing of Col. 3 in the 10-story "typical" office building of Table I is 35,6[illegible] lb. while the column is proportioned for a live lo[illegible] of 204,500 lb. The "probable maximum live load" assumed in Table III for the Moran method are [illegible] lb. per sq.ft. for the floors and 20 lb. for the roof. [I]n the 4-story factory building which Moran gives as an illustrative example, he assumes the probable maximum live loads and wind loads on the footings to be 60 per cent and 50 per cent respectively of those used for proportioning the lower sections of columns.

Wind Load on Footings.—In proportioning footings should wind loads be included with live loads, as in the Moran method? Some building codes include them by specific mention, others by implication, others are ambiguous, and others exclude them by specifying that the live loads to be considered are those of a designated section in which no mention is made of wind loads. An instance is the former New York code previously quoted. The section 130 to which reference is made contains nothing about wind loads. Wind loads can be neglected in many buildings but, at least with respect to the strength of the frame, they should be considered in high narrow buildings and in structures where the materials of construction offer but little resisting moment to the wind. It seems reasonable to take account of them in the footing design. (See the writer's proposed specifications.)

It is of prime importance that the center of gravity of pressure on a foundation should coincide with the center of gravity of resistance. Bauman in his pamphlet lays down as one of the three fundamental rules in designing foundations that they must be made to support their loads centrally. The neglect of this rule is a frequent cause of foundation trouble. It is often a difficult matter to take care of exterior columns and party walls properly, especially where spread foundations are used. We are indebted to Chicago for the cantilever solution of the problem, said to have been first used in the Rand-McNally Building. For mathematical treatment of eccentric loading, cantilever girders and combined footings, the reader is referred to text-books, and for illustrative examples to the files of the technical press.

Table III is for reference and explains itself. It is based on an allowable soil pressure 6,000 lb. per sq. ft. By using it with Table I the unit pressures on footings for live, dead and total loads can easily be obtained.

The writer offers the following specifications for

TABLE III. AREAS OF FOOTINGS FOR TYPICAL OFFICE BUILDINGS

(Areas in Square Feet)

Stories	Column No.	Dead Plus Live	Dead Plus 60 per Cent Live	Method of Proportioning: Crehore and Schneider	Tucker	McCullough	Moran	Proposed Method
6	1	29.0	26.5	44.7	38.5	29.0	41.3	37.0
	2	41.3	36.5	57.0	50.8	37.0	53.6	49.0
	3	49.3	39.8	49.3	49.3	32.0	49.3	49.3
8	1	38.9	36.0	59.8	51.6	38.9	55.3	49.6
	2	54.5	48.6	75.4	67.4	49.9	70.9	65.3
	3	62.4	50.6	62.4	62.4	40.6	62.4	62.4
10	1	48.6	45.2	73.9	64.3	48.6	68.2	61.8
	2	67.3	60.4	92.4	82.9	60.9	86.9	80.5
	3	74.6	60.9	74.6	74.6	49.0	74.6	74.6

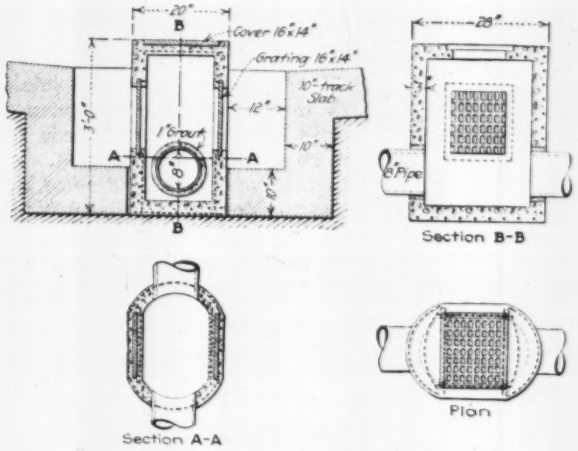
NOTE: Same buildings as those of Table I.

determining the areas of footing courses of foundations in buildings:

The live loads on foundations shall be assumed to be the same as those on the lowest sections of columns. No wind load, however, need be considered unless it exceeds one-half the sum of the live and dead loads on the column. In case of excess, the excess shall be considered a live load.

The areas of footings shall have the same ratio to each other as the dead plus one-third live loads coming upon them. That footing which receives the largest percentage of live load shall be proportioned for the combined dead and live loads. The dead plus one-third live load on this footing shall be divided by the area thus found, and this reduced pressure per square foot shall be used for the dead plus one-third live load of all foundations.

It is thought that the proposed specifications are well adapted to the general case of foundations. However, the foundation problem is one that is always with us and requires trained judgment and technical skill to meet the many special forms in which it is constantly appearing.

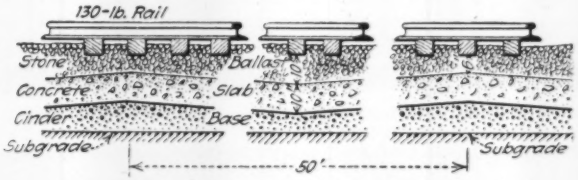


DRAIN INLET FOR TRACK ON CONCRETE

Concrete Base Track Approach for Chicago Union Station

Roadbed Near Water Level Blanketed with Concrete To Prevent Settlement of Ballast—Heavy Track Construction

TO REDUCE maintenance work under heavy terminal traffic, a concrete slab foundation will be placed under the tracks and crossovers at the south approach to the new Chicago Union Station, thus distributing the load on the subgrade and preventing the ballast from settling into the earth. This four-track approach not only carries exceptionally heavy traffic but includes a series of double crossovers with slip switches by which any one of the main tracks can be connected to any one of the station or platform tracks.



CONCRETE SLAB SUPPORTS BALLASTED TRACK

The pounding of heavy engines in passing through the crossovers and crossing frogs would soon work the ballast into the roadbed, which is necessarily somewhat soft since the rail level is only about 4 ft. above the water line of the Chicago River, which flows close to the tracks. With ordinary track construction in this case there would be continual work in surfacing and lining the tracks and complicated special work. In the station there will be a concrete deck or floor with recesses for wood blocks carrying the rails, as in the underground terminal station of the Pennsylvania R.R. at New York and the elevated union station at Indianapolis, Ind.

From the end of this deck, at Harrison St. the concrete slab with ballasted track will extend about 800 ft. to Taylor St. The width of slab varies from 100 ft. at the station to about 56 ft. at the further end. It was built in three longitudinal sections, as only part of the approach could be vacated at one time. The construction is similar to, but heavier than, that employed under the crossovers in the Long Island R.R. terminal yard at Jamaica, N. Y., as described in *Engineering News-Record* of April 22, 1920, p. 826.

On the subgrade was laid a 12-in. bed of cinders, which was compacted by rolling and the surface of which was formed in drainage planes. Upon this base was laid the 10-in. concrete slab, of uniform thickness and following the surface of the cinder bed so that it is sloped to form a series of transverse valleys about 50 ft. wide between ridges and 4 in. deep. The concrete is a 1:2½:5 mix, made with broken stone. In order to prevent shrinkage cracks it is reinforced at the middle with a sheet of wire netting and transverse rods. Each section was built as a monolithic block 800 ft. long, and was left for at least seven days before the ballasted track was placed upon it. A small portable mixer was used for the work.

Provision for Drainage

Under the slab are 8-in. transverse tile drains which are intersected by a 12-in. longitudinal drain having sewer connections. Inlets and manholes extend through the slab and ballast and have iron covers at the level of base of rail. The inlets have iron gratings in the sides and stand in recesses or drainage sumps formed in the surface of the slab, as shown by the drawings. Electric conduits are also placed under the slab. They consist of fiber ducts embedded in concrete and have manholes at intervals.

Track of heavy construction is used, further to reduce maintenance. The ballast is of 2½-in. broken stone, 6 in. and 10 in. thick under the ties at the ridges and valleys of the concrete slab. In this are bedded ties of creosoted red oak, 7 x 9 in., spaced 20 in. c to c. Rails of the 130-lb. Pennsylvania R.R. section are laid on steel shoulder tie-plates and are secured by ordinary 6-in. cut spikes. The tie-plates are fastened to the tie by similar spikes, independent of those which hold the rails. Manganese steel will be used for the special work of the crossovers, which will have 18-ft. switch rails and No. 8 frogs. The main tracks are spaced 13 ft. c. to c.

Design and construction of this track system were under the direction of J. d'Esposito, chief engineer, and A. J. Hammond, assistant chief engineer of the Chicago Union Station Co.

New Experiments on Riveted Joints of Ship Plating

DETERMINATIONS of the slip of riveted joints, intended primarily to apply to ship construction, were carried out recently by James Montgomerie for the Committee of Lloyd's Register of Shipping. As described in the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, April, 1920, the experiments show rather high values of load at first slip, though it should be noted that static loading only was employed. Comparison of pneumatic, hydraulic and hand-driven rivets showed no appreciable difference in either the elastic qualities or the ultimate strength of the joints; and in fact iron rivets behaved substantially the same as steel rivets.

Test Material

The test material included six triple-riveted lap joints of plates 23½ in. wide by 0.44 in. thick connected by twenty-seven rivets of ¾-in. diameter; and six quadruple-riveted joints of plates 17 in. wide by 0.58 in. thick connected by twenty rivets of ¾-in. diameter. In the former, slip occurred at loads ranging from 16,000 to 20,000 lb. per square inch of rivet area, or 18,000 to 22,600 lb. per square inch of what is designated as "unpierced plate."

In the second series the slip loads were somewhat lower, ranging from 15,000 to 17,700 lb. per square inch of rivet cross-section, and from 18,000 to 21,700 lb. per square inch of section of unpierced plate. The tests were not extensive enough to give very precise averages, as in each series of six tests there were two specimens with hydraulic-driven rivets, two with pneumatic-driven rivets, and two with hand-driven rivets, and in each pair one specimen had steel rivets and the other iron rivets. In effect, therefore, the tests of the riveted joints were all individual.

Dr. Montgomerie concluded from his observations on the test that the load does not distribute evenly among the rivets, and the stress distribution in the joint is by no means uniform; that the contact face of the plate carries nearly double the average stress; that up to the point where slip begins the joint behaves as an elastic solid; that the iron and steel and the different methods of riveting give results that could not be differentiated in these tests; that the load at first slip may be taken to be 17,000 to 18,000 lb. per square inch of rivet section; and that subsequent to slip "the joint recovers its power of adhesion" and on retesting after an interval it will be found to give the same results as were obtained in the first test.

Congress Would Pay Engineers Less Than Engineering Council

ON MARCH 12, 1920, the Congressional Joint Commission on Reclassification of Salaries presented its report to Congress. Ever since this report was made public, discussion concerning it has been rife, and naturally much misunderstanding about the recommendations regarding salary schedules and employment policies has gained currency. In an endeavor to clear up these misunderstandings and in order to present an analysis of the commission's report, Engineering Council's Committee on Classification and Compensation of Engineers has prepared a "Comparison of Report of the Congressional Joint Commission on Reclassification of Salaries with the December, 1919, Report of Council's Committee." From that report the accompanying table is reproduced herewith:

COMPARISON OF CLASSIFICATION AND COMPENSATION OF ENGINEERS AS SUGGESTED BY ENGINEERING COUNCIL'S COMMITTEE AND BY CONGRESSIONAL JOINT COMMISSION

	Engineering Council — Annual Salary Range					Congressional Joint Commission — Annual Salary Range						
Grade	Title	Educational Equivalent	Minimum Experience in Years	Minimum	Maximum	Estimated Average	Title	Educational Equivalent	Minimum Experience in Years	Minimum	Maximum	Estimated Average	Present Average Yearly Salary (Note)	Average per Cent Increase or Decrease (Note)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	a Junior asst. office b Junior asst. field	High School	0	1,080	1,560	1,240	a Copyist draftsman b Junior engineer's aid	High School / Common School	0	840	1,260	980	1,215	—19
7	a Asst. office b Asst. field	High School	2	1,680	2,400	1,920	a Draftsman b Aid	High School	2	1,200	1,800	1,400	1,533	— 9
6	a Senior asst. office b Senior asst. field	High School	5	2,520	3,240	2,760	No corresponding grades	....	....	....	....	....	....	....
5	Junior assistant engineer	Degree	0	1,620	2,580	1,940	Junior engineer	Degree	0	1,800	2,160	1,920	1,959	— 2
4	Assistant engineer	Degree	2	2,700	4,140	3,180	Assistant engineer	Degree	2	2,400	3,000	2,600	2,402	+ 8
3	Senior assistant engineer	Degree	5 1*	4,320	5,760	4,800	Associate engineer	Degree	5 1*	3,240	3,840	3,440	3,128	+10
2	Engineer	Degree	8 3*	5,940	....	....	Engineer	Degree	8 4*	4,140	5,040	4,440	3,801	+17
1	Chief engineer	Degree	12 5*	8,100	....	....	a Senior engineer b Commissioner, director, chief engineer, chief, superintendent, etc.	Degree Degree	12 8* 8 *	....	....	....	5,867	....

NOTES

Columns 4 and 10. *Years in responsible charge of work.

Columns 7 and 13. Estimated average salary is the minimum plus one third the difference between the minimum and the maximum. This relation was found to hold approximately for positions in the Federal Service, and was assumed in the studies conducted in connection with the salary schedules of the Reclassification Commission.

Column 14. Present average yearly salary, including bonus, of employees in sixteen bureaus in civil establishments of the Federal Government. The bonus is $240 for salaries of $2,500 and under; for salaries above $2,500, it is the amount, if any, necessary to make a total of $2,740.

Column 15. Average percentage increase (+) or decrease (—) in pay per employee under schedule proposed by Congressional Joint Commission over present schedule, if distribution of employees within each grade remains unchanged. The estimated increase in the salary roll which would be caused by putting the Commission's recommendations for all branches of the Civil Service into effect is, as estimated by the Commission, 8 to 10 per cent—probably 8.5 per cent.

Hydraulic Control of the Red River of the North

Detention Basin, Channel and Drainage Ditches at Head of 300-Mile Flat Valley—Project for Interstate Action

TO CONVERT Lake Traverse into a detention reservoir by a dam with permanent outlet, to straighten and improve the Bois de Sioux River for nearly 30 miles from this outlet to the Otter Tail River, and to construct main ditches to drain the land below the reservoir, are the preliminary steps of an interstate project for drainage and flood control in the valley of the Red River of the North, which last stream is formed by the junction of the other two streams between Breckenridge, Minn. and Wahpeton, N. D. The proposed works are shown on the map, Fig. 1.

As Lake Traverse, the Bois de Sioux and the Red River constitute the boundary between Minnesota on the east and South Dakota and North Dakota on the west, these three states have a mutual interest in the problems of securing outlets for drainage and flood waters. On the other hand, they have certain conflicting interests, since it has been claimed that channel improvements and drainage works along the Mustinka River in Minnesota have increased the discharge into Lake Traverse, causing floods on the western lands. The two Dakotas, therefore, have combined in a damage suit against Minnesota. This suit is now before the Federal courts.

The Red River of the North flows almost directly north, crossing the Canadian boundary and discharging into Lake Winnipeg. Although the direct distance from Breckenridge is about 290 miles, the length of the river is over 500 miles owing to the tortuous windings of the channel, which windings do not extend more than five miles on either side of the direct line. The slope varies from 0.3 to 1 ft. per mile, but in the Bois de Sioux the former is the average. The annual run-off averages about 3 in. for the Minnesota drainage area and less than 1 in. on the Dakota side.

Owing to the slight slope and a run-off insufficient to cause much scouring, the channel has not developed sufficiently to carry the flood waters. In fact, at the outlet from Lake Traverse there is practically no channel. In the Bois de Sioux the elevation is about 970 ft. at the lake and 945 ft. at its junction with the Otter Tail. The lake has a drainage area of 1,300 sq.mi. and a water area of about 30 sq.mi. A peculiar condition noted by Prof. E. F. Chandler in his pamphlet on "The Floods of the Red River Valley" is that while the country along the river (below Breckenridge) is flat it is several feet above the low water channel, so that normally it is dry and not swampy. But when the channel overflows a wide area is covered with shallow water of sluggish flow, and after the river recedes this water remains for a considerable period.

Serious floods at various points along the river in the summer of 1916 led the Commercial Club of Fargo, N. D., to request the U. S. Department of Agriculture to have a survey made for the purpose of determining some means of relief. After a study of the situation by S. H. McCrory, chief of drainage investigations, Bureau of Public Roads, it was reported that relief could be secured only through concerted action by the three states, and that an examination would be made by the Bureau if funds were raised to defray certain expenses. In the meantime, the North Dakota Flood Control Commission had been appointed by the legislature and in 1918 the necessary money was raised largely through this commission. Field work was carried out during 1918 and 1919, and early in 1920 a progress report was made on the conditions at Lake Traverse and the Bois de Sioux River, as these called for immediate attention. A later report will deal with the conditions of the Red River proper.

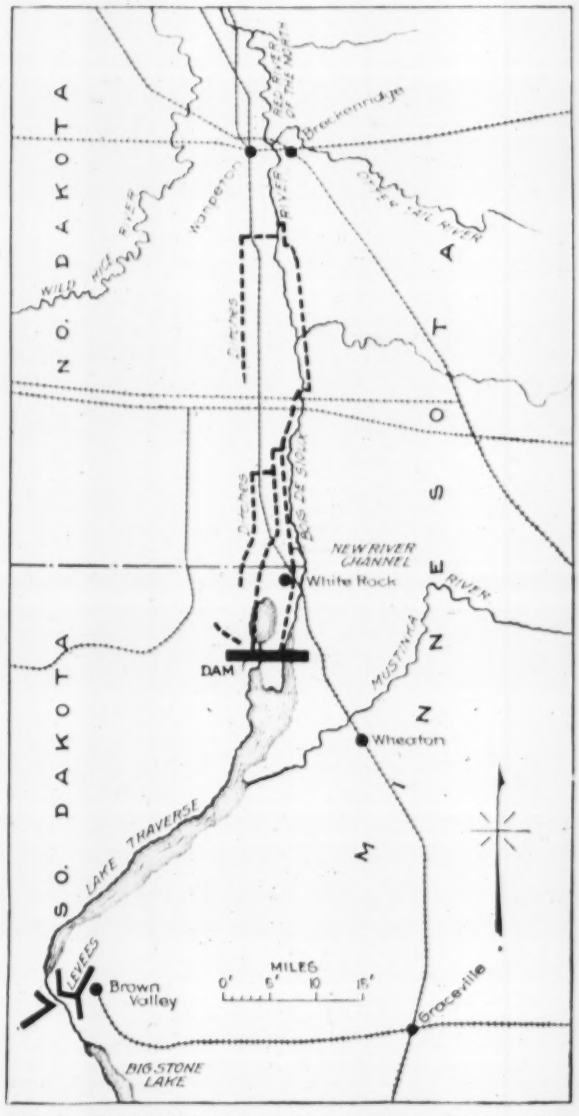


FIG. 1. DRAINAGE AND FLOOD CONTROL WORKS FOR RED RIVER OF THE NORTH

As the channel of the Bois de Sioux River is too small to remove the water from heavy rains and melting snow much lowland is flooded periodically and thus obstructs the drainage of higher land. The flood waters either drain off slowly through the inadequate channel and outlet or remain until evaporated. Spring floods delay planting and summer floods cause serious damage to crops. The soil is alluvial and very fertile. The western portion of the drainage area and a strip extending about 30 miles east of the lake and the Bois de Sioux is prairie land with an easy slope. About 80 per cent of this prairie land is under cultivation. The eastern

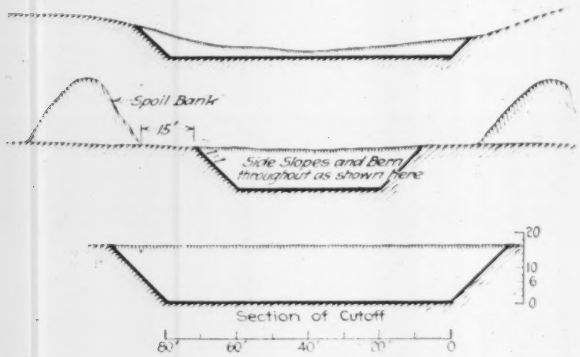


FIG. 2. CHANNEL IMPROVEMENT OF BOIS DE SIOUX RIVER

portion is rough and originally was covered by forests, but only about 10 per cent of the total drainage area is now wooded.

On both portions the natural drainage is poorly developed. Many drainage ditches have been constructed and in some places these have modified the natural drainage considerably. There is very little tile drainage. From the investigations of the drainage systems it was concluded that with excessive rainfall or rapid melting of snow the ditches may increase the rate of run-off when the drainage area is impervious from being frozen or saturated. This increased run-off may tend to increase flood heights along an unimproved portion of the stream having an inadequate outlet.

An annual run-off of 23,430,000,000 cu.ft. was determined as a maximum for the drainage area of Lake Traverse. To control this by converting the lake into a detention reservoir, it is proposed to build an earth dam about 2¾ miles long and 15 ft. high across the two outlets at the northern end, four miles south of White Rock, S. D. A concrete sluiceway would provide for normal discharge. A spillway for maximum discharge would have its crest at El. 983, with capacity for discharging 2,000 cu.ft. per second when the lake level reaches El. 985. The combined capacity of culvert and spillway would be 4,000 cu.ft. per second, which is far in excess of any probable requirements. At the south end of the lake, levees would be built for the protection of low lands. The reservoir capacity would be 9,849,000,000 and 12,035,000,000 cu.ft. at the two elevations mentioned.

Below the outlet a defined and direct channel would be built along or near the present winding course of the Bois de Sioux, with levees on each side to retain flood discharge. Typical cross sections are shown in Fig. 2.

These proposed improvements are designed to control the run-off from the upper drainage area of 1,335 square miles above the dam. This control would be effected in three ways: by storing in the reservoir all the run-off during March and April; by storing after May 1 any flow in excess of the 1,000 cu.ft. per second discharged through the control outlet; by storing all the run-off that occurs during any summer period when the run-off from territory below the dam fills the discharge channel.

To drain the reclaimed land on either side of this channel, or the straightened Bois de Sioux River, there would be main ditches practically parallel with the channel and having a fall towards the north. These ditches would serve also to relieve the upper part of the channel from the run-off of the adjacent land, below the d... Drainage works under the plan proposed would pro... outlets for water from 112,370 acres below the dam, ... area having at present no adequate outlets. The ... and the Bois de Sioux constitute the drainage out... for 1,200,000 acres or 1,875 square miles, the drain... from which affects that of the smaller area served ... the ditches. Of the 112,370 acres, there are 31,1... acres in Minnesota, 75,160 acres in North Dakota and 6,070 acres in South Dakota. The plans do not include lateral drains in this territory, as it is considered that these should be provided under the drainage laws of the individual states rather than as part of the joint or interstate project.

The total cost is estimated at $1,400,000, the main items being as follows: Earth dam, $107,950; outlet culvert and approach, $93,660; spillway, $66,960; levees at south end of reservoir, $39,970; Bois de Sioux channel, $394,770; ditches $198,900; bridges, $89,260; flowage rights, $284,760. If this cost is assessed against the area of 112,370 acres directly affected, the cost would be $12.50 per acre, which is considered reasonable. But this amount could be reduced by assessing part of the expense against the 1,087,630 acres, which comprise the upper portion of the drainage area of the lake and Bois de Sioux, this portion being affected indirectly by the improvement.

The progress report which has been mentioned, and from which the above information has been compiled, is by P. T. Simons, senior drainage engineer, U. S. Department of Agriculture, who has been in charge of the investigation, assisted by F. V. King and Guy L. Smith, drainage engineers. The report was prepared under the direction of S. H. McCrory, chief of drainage investigations, U. S. Department of Agriculture. Before constructive action can be taken, some form of local organization must be perfected to finance the project and to assume charge of the construction and operation of the works. Interested property owners are making efforts to form such an organization and to secure co-operation in the three states.

Unusual Conditions in Side Launching

A steel river barge was launched at Stillwater, Minn., with a drop of 11 ft. from floor to water surface, in 3 ft. of water. The officials of the Minneapolis Steel & Machinery Co., builder of the barge, expected possible difficulties on account of the shallow depth, but the barge went into the water successfully and received no damage. For launching with a high drop this event is believed to set a record in respect of shallowness of water.

Last year the water in the St. Croix River was exceptionally low and on Sept. 13, when the barge was to be launched, there was less than 2 ft. depth at the end of the ways. A scraper hauled by a line from the derrick and guided by two men wading was used to dredge out a basin, and in addition a few charges of dynamite were set off in front of the groundways to make holes that would provide for the cradles getting clear. Still it was thought possible that the leading bilge would strike the bottom and that the cradles might jam between the barge and the ground and damage the hull when the inshore bilge struck the water. No damage resulted, however, and the barge floated clear after entering the water.

Three Factors Affecting the Construction Industry

THE three factors most vitally affecting the construction industry—transportation, prices and labor—are discussed in a recent issue of the Associated General Contractors' bulletin by W. A. Rogers, president of the association and of the Bates & Rogers Construction Co., Chicago. His views on the stabilization of the construction industry through treatment of these factors are reproduced herewith:

In order that any program of construction may be developed for the coming six months, we must first devise ways and means to (1) adjust transportation conditions; (2) establish sound price levels for construction material; and (3) secure from labor its full efficiency. In direct proportion to the extent to which these questions are settled will

Ultimately, the transportation problem is largely one of rates and control. With adequate rates assured at the earliest possible date, the equipment and facilities of the roads can be maintained in relation to the demands being made upon them; and wages commensurate with the service rendered can be paid. It will take time, however, to repair present equipment, build new rolling stock and increase facilities. Meanwhile, we shall have to adopt some plan of sharing present facilities with other industries in proportion to the need for each. Since rates cannot be shifted like prices, according to supply and demand, some other means must be adopted in apportioning transportation facilities. This means the re-establishment of priorities sooner or later in some form or other. Already this has been started. From present indications, if construction is not to be practically suspended in some sections of the country, construction materials must be given the right of way over other less essential commodities, second only to food and fuel. With inadequate facilities at hand, only by curbing the distribution of luxuries which have jammed our freight houses and made use of cars which should have gone to more essential needs can the present situation be handled and construction proceed.

Sound price levels are fundamentally a matter of publicity, for, with confidence in the justice of present prices restored which would follow full publicity of costs and profits, fear that a slump may be just around the corner will be removed. Then normal buying will be restored by the knowledge that lower prices can only be had as a result of slowly deflating the world's currency and slowly increasing the world's production, processes which will require time to accomplish. Without such knowledge, investors will hesitate to build and banks to finance new projects.

The increased efficiency is mainly to create a new ideal in industry—the ideal of increased production. But such an ideal is of little value without an incentive behind it. During the war patriotism and the spirit of teamwork for a common aim supplied that incentive. If workmen continue to demand increases in wages, shorter hours and decreased production, they may automatically create such an incentive in the competition among themselves for jobs, because of a slowing down in construction. Better, if means could be devised, to increase the efficiency of all construction labor at rates satisfactory to all!

The elimination of restrictions on output is fundamental. Moreover, if some plan could be worked out by which there would be restored the mutual confidence between the contractor and the employee by means of which it would be impressed on both that their interests were identical and that in the long-run decreased production costs the workman as much as it does the employer, then a long step in the right direction will have been taken.

In spite of these things, however, there is one outstanding feature in the present outlook for construction: The need for new public works of all kinds, which are subordinate only to the need for food and fuel. The proportion of these which will be undertaken during the coming six months will depend upon the extent to which we solve the three major problems outlined above.

Notes from Foreign Fields

ENGINEERING SOCIETY ORGANIZATION IN GREAT BRITAIN

BY E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

BECAUSE of the ferment in the organization of engineering societies in the United States the American visitor in Britain naturally inquires what the situation is here. Is there agitation for changes in the older societies? Is there demand for greater activity? Are there efforts to organize for civic and welfare work?

Young men are the same the world over. One must expect everywhere a certain amount of dissatisfaction among them. The older societies here are not free from the criticism that they might be more active. That criticism, however, is not of the same volume as we find in the States, nor does it take on the same degree of asperity.

The older societies, with long traditions and the confidence that comes from a sound policy successfully pursued during many years, are little disturbed by such criticisms, recognizing that youth expects too much and is not always sound in its proposals. That does not mean that older societies are indifferent to the demands of the changing years. In fact, as will be instanced, one of these regarding which I have specifically inquired—the Institution of Civil Engineers—has changes in hand that will increase the service rendered its members.

Among the younger men there is under way at present the organization of a society much on the lines of our American Association of Engineers. It bears the name of the Society of Technical Engineers, and since it was formed to further the welfare of its members, it must, under the British law, be registered as a Trades Union. This does not mean that it has any affiliation with the manual trades unions. In fact it distinctly has no connection with them. It is a trade union merely within the construction of the British law, under which even an association of employers banded together to promote their personal welfare would be considered a trade union.

The mention here of trades unions brings to mind the efforts that the labor leaders in Great Britain made some time ago to bring about an affiliation between labor and the professional classes. Some of the young men of the Sidney Webb school of thought—a socialistic group which has very great influence in England with the labor leaders—called a conference of professional societies in February with the hope and purpose of securing the passage of resolutions definitely allying the professional men with the labor movement. The meeting was held, but as might have been expected from a body truly representative of professional men, the labor leaders were unable to get from the meeting the resolutions they desired. In other words, in a clear and direct test professional organizations have refused to ally themselves with the labor movement. The reason for that is the very same which Morris L. Cooke advanced when he protested against the alliance of the

American Society of Mechanical Engineers with a strictly capitalistic organization, the National Industrial Conference Board, namely, that the engineer, the professional man, must have alliances with neither party, but must be in a position to act as mediator and conciliator between them.

Of the federation of engineering societies here I have heard no talk whatsoever. There is no such body as our Engineering Council, but apparently on important questions the societies appoint special committees for cooperative effort.

New Movements in the Institution

Mention has been made of internal developments in the Institution of Civil Engineers. First and foremost of these is the discussion now under way looking to the registration of engineers. As readers of *Engineering News-Record* know, the members of the Institution by letter ballot indicated their approval of the proposal to have introduced in Parliament a registration bill. Accordingly a measure was drawn up and submitted for discussion to the leading engineering institutions. There was much criticism among the smaller societies, mainly because these smaller bodies objected to the Institution being the sole body to determine what were the proper qualifications for an engineer. Members of other institutions to whom I have talked, while feeling that there should be a joint body to lay down the qualifications, admitted freely that the Institution of Civil Engineers was the only body in Great Britain which could take the leadership in furthering a registration bill.

For the present the matter is in abeyance, due to the inability of Parliament to consider at this session any but the most pressing national measures. Representatives of the leading engineering institutions are conferring on the preliminary draft, insuring vigorous and harmonious effort when the Parliamentary machinery will permit of the introduction of the measure.

It should be made perfectly clear for the information of our people that this is in no sense a licensing bill. Its purpose is not to say who shall practice the profession of engineering, but merely to protect the title, Civil Engineer. In other words, one may practice engineering, should this measure as planned by the institutions prevail whether he be registered or not, but without such registration he may not designate himself as a Civil Engineer. Dr. Tudsbery expressed the view that it would be improper for the Institution to ask for restrictive legislation. If the Government, in the interest of the public, should think it necessary to prohibit anyone from practising engineering until he had been licensed, it would be for the Government to assume the initiative. This is a far more conservative position than has been assumed by those engineers in the United States who have promoted licensing laws.

It is particularly important that this matter be correctly understood in the United States. At one of the meetings of the New York Section of the American Society of Civil Engineers it was definitely stated that the Institution's proposed bill would prohibit American engineers from practising in Great Britain. On the authority of Dr. Tudsbery himself, I am able to state positively that such would not be the case. If, however, a registration bill along the lines under discussion should prevail an American could not use the designation, Civil Engineer, unless he qualified and was properly registered.

Of the other new activities of the Institution that [illegible] expanding its present local students branches into g[illegible]eral branches has resemblance to developments in [illegible] United States. Thus far the Institution has had o[illegible] student branches. From now on members in any gr[illegible] will be admitted to the branch organization, but [illegible] subsidy from headquarters will be confined to the jun[illegible] part of the branch membership. The older membe[illegible] will have to finance that part of the activities which [illegible] due to their own participation.

Another development which will have interest for us [illegible] the arrangements soon to be put into effect by whi[illegible] the great library of the Institution will become a loa[illegible] library. Until now it has been a reference library, an[illegible] books could not be borrowed. Henceforth, a membe[illegible] may borrow any of the volumes, thus removing th[illegible] criticism that the most valuable asset of the Institution was not of service to the members at a distance.

From what has been said therefore, it will be apparent that the Institution has a forward looking point of view, that it is intent on increasing its service to its members.

The Institution, however, like our American Society of Civil Engineers, believe that its best service to its members can be rendered only by steadfast adherence to its technical purposes. So strongly is that felt that when it became apparent some years ago that there was need for what we would call an "employment bureau," some of the leading members of the Institution formed an independent organization, known as the Civil Engineers' Appointment Board, feeling that it would be an erroneous step for the Institution to depart from its technical functions and go into employment work. The Board is supported almost entirely from the fees paid by those who secure positions, but the Institution gladly donates certain clerical services, while Dr. Tudsbery in a private capacity and not as Secretary of the Institution, holds membership in the board. The board maintains its own offices a short distance from the Institution's home and in every way maintains its separate identity.

This arrangement indicates that the leading engineers of Great Britain are alive to the demands that may arise, and when they deem them sound are ready to erect separate organizations for them if the activities go beyond what they believe to be the proper scope of the Institution. Obviously their judgment as to what is sound will not agree with that of all engineers, particularly of the restless men in the younger group—but have we not ourselves worked to the conclusion that for men of many minds there must be different organizations?

London, May 21.

Will Try Concrete Parapets on Elevated Railway Stations

Four station platforms in Frankford, of the new Frankford elevated line built by the city of Philadelphia, have a concrete parapet or railing. This is lower in cost than steel inclosure, and will not need painting. H. H. Quimby, chief engineer of the Department of City Transit, states in his 1919 report, just issued, that these concrete parapets are considered somewhat of an experiment, and their performance will be compared with that of the steel parapets on the other platforms.

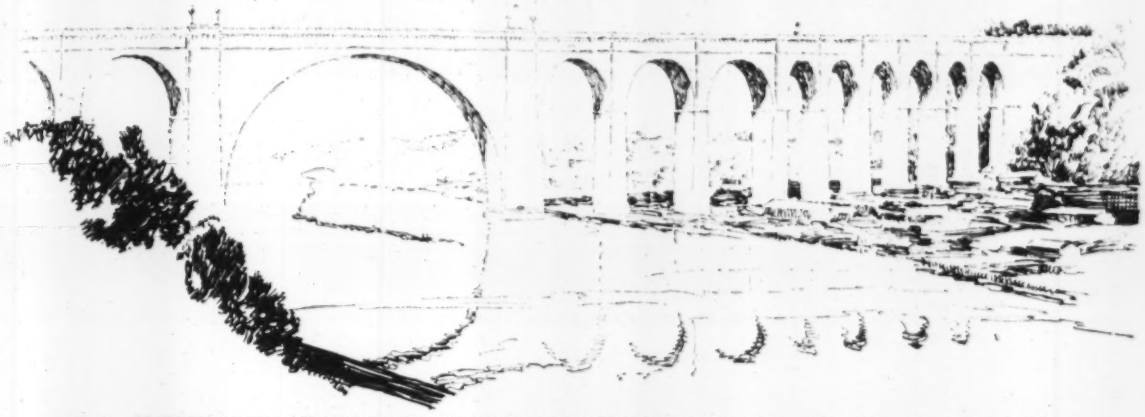


FIG. 1. SKETCH VIEW OF HIGH BRIDGE WITH RECONSTRUCTED RIVER CROSSING AS PROPOSED BY WILGUS COMMITTEE

Suggested Plan for Reconstructing Aqueduct High Bridge

Consulting Engineers' and Architects' Societies Join in Plan to Save Aqueduct Bridge Built by J. B. Jervis

DEMAND has been made by the U. S. War Department that the river piers of High Bridge, the crossing of the first Croton aqueduct over the Harlem River at New York, be removed in the interest of navigation. Out of this situation there has now developed a project for reconstructing the bridge by building a single large span to cross the river, and so avoiding its demolition. The American Institute of Consulting Engineers and the New York Chapter of the American Institute of Architects joined in working out the project and bringing it to the attention of the city authorities. As representative of the joint committee of the two societies, Col. W. J. Wilgus calls on engineers for support of the movement to save the bridge not only because of its value as a reserve conduit in the aqueduct system of New York City, but also because of the historical importance of the structure as one of the great engineering works of an early period of American engineering and as one of the prominent works of John B. Jervis, railroad builder and chief engineer of the Croton Aqueduct Commission, one of the pioneers of American civil engineering.

A perspective sketch of the bridge as it would appear after the proposed reconstruction is reproduced in Fig. 1 herewith. The existing spans are semicircular arches of 80 ft. in the clear. The reconstruction according to the committee's plan would substitute a single 231-ft. span of semi-elliptic form for three of the present spans. Enough of the structural problem has been worked out to make it possible to outline the general procedure to be followed in the reconstruction, and to enable cost estimates to be made. The large arch is to be carried on foundations that in appearance are extensions of the existing pier foundations, but actually are independent of them, so that settlement of the new part will not injure the old work. The additional pier masonry also is separated from the old masonry by a vertical slip joint with regard for possible settlement. As indicated in the drawing, Fig. 2, a horizontal concrete strut below ground level would anchor the abutment pier on the Manhattan or west bank, which stands on piles, to the rock of the adjacent hillside.

When the War Department made its demand for removal of the river piers of High Bridge, six months or more ago, complete removal of the bridge was advocated by the city's Department of Plant and Structures, which has charge of bridges, while on the other hand the

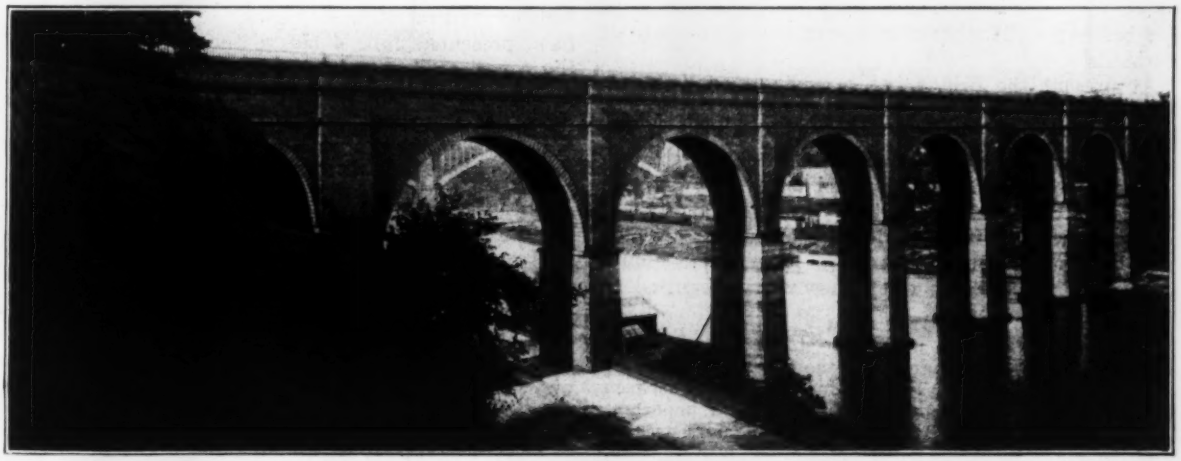


FIG. 3. HIGH BRIDGE AS ORIGINALLY CONSTRUCTED AND AS IT APPEARS TODAY

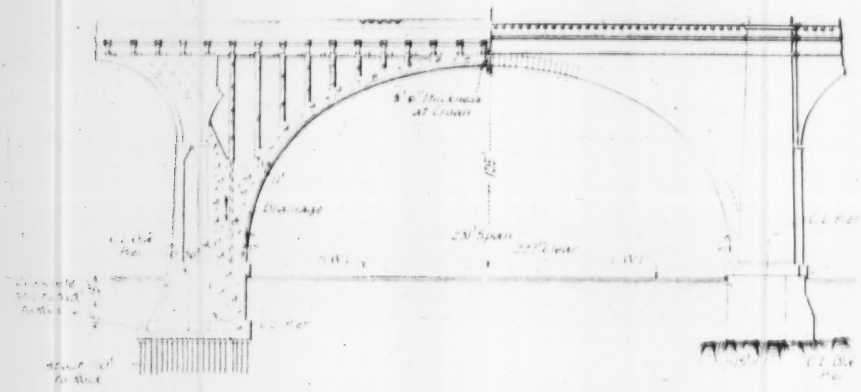


FIG. 2. CONSTRUCTION OF LARGE ARCH FOR HIGH BRIDGE CROSSING OVER HARLEM RIVER

Department of Water Supply urged that the structure be preserved for its value as an emergency reserve to supplement the tunnel crossing of the aqueduct under the Harlem River. To meet the latter demand E. A. Byrne, chief engineer of the Department of Plant and Structures, proposed a method of reconstruction which involved removal of alternate piers and replacement of successive pairs of arches by steel plate-girder spans masked by a masonry shell in the shape of a flat arch.

At this time a group of members of the American Institute of Consulting Engineers, headed by Colonel Wilgus, interested themselves in the matter with the object not only of preventing the demolition of the famous old bridge but also of maintaining its structural and esthetic character as nearly unchanged as possible. Through action of this group, a committee of the Institute was appointed to study the problem and recommend a solution, made up of Colonel Wilgus (ch.), C. W. Leavitt, Ralph Modjeski, and Allen Hazen. Because of the esthetic phase of the matter and the importance of applying trained perception of form to the rather difficult task of combining new and old parts of a structure of different proportions in a harmonious way, the committee secured the co-operation of a committee of the New York Chapter, American Institute of Architects, comprising Henry Bacon, A. W. Brunner, and Ernest Flagg. The project shown by the illustration herewith is the result of the joint work of these committees aided by C. E. Chase of Mr. Modjeski's office. It has been laid before the Finance Committee of the city's Board of Estimate.

At present the bridge has a width of only 21 ft. There is opportunity for widening it slightly by providing a slab roadway deck overhanging the sides of the arch and supported by brackets. This would enable the bridge to be utilized as an automobile roadway between Manhattan and Bronx boroughs. The traffic value of the bridge as well as its historical importance is touched upon in the following extract from the memorandum accompanying the plans when they were submitted to the Board of Estimate:

> High Bridge from the utilitarian standpoint serves the purpose not only of safeguarding the city's water supply but also of a means of connection for pedestrians between Manhattan and the Bronx, and as such is an important adjunct to High Bridge Park. Moreover, it offers promise of ultimately becoming an important thoroughfare for automobiles between the two boroughs through a slight modification of the top of the viaduct so as to serve both vehicles and pedestrians. As there is a distance of over a mile without a street connection between the two boroughs from the Macomb's Dam Bridge at 155th St. to the Washington Bridge at 181st St., it will be seen that this possibility of utilizing the High Bridge viaduct as an intermediate street connection is a weighty argument in favor of the retention of the structure, especially when the inconsiderable expense of so doing is contrasted with the contemplated expenditure by the states of New York and New Jersey of some $14,000,000 for a roadway of no greater width from lower Manhattan to Jersey City.
>
> However, it is not only from a utilitarian standpoint that this structure should be considered. In an historic sense it is one of the city's most striking monuments in marking the inauguration three-quarters of a century ago of the Croton water supply, and second, in honoring the memory of one of America's most famous engineers, J. B. Jervis, who was the constructive genius of the Erie Canal, the Croton water supply, and the Hudson River R.R., three public works that have had so much to do with the prosperity of this city.
>
> From an artistic standpoint it would seem that every effort should be made to preserve this structure, which is one of the few examples of esthetic engineering in America. Its design places it in the same class as the famous Roman aqueducts, the remains of which are among the chief attractions of the Old World.

It is estimated that at present prices the cost of carrying out the project here shown would be $830,000. Demolition of the bridge would cost $500,000. Reconstruction of the river portion by removal of alternate piers and substitution of masked plate-girder spans for pairs of the present spans would be intermediate in cost between the two. The plans for a single span arch as shown has been approved by the U. S. Engineer Officer of the New York District, Colonel Edward Burr, as being satisfactory from the standpoint of navigation.

Poor Policy To Boast of Low Engineering Costs

The following extracts are from a paper "Some Problems of the Practising Engineer," by John W. Cunningham, presented June 4 before the Oregon Chapter of the American Association of Engineers:

> Engineers have unwittingly worked against their own interests by quoting and in fact boasting of low engineering costs for work done under their direction. While those costs may have been the result of efficiency, they also may have been governed by several other factors, and equal credit might have been secured in other ways, by pointing to the excellence of the design and construction and to low total cost.
>
> The legal and medical professions have long ago learned that it was poor policy to emphasize the low cost of their services. A lawyer will point with pride to difficult cases won, but does not say how cheaply they were handled. Similarly, in the medical profession, the only individuals who publicly advertise the inexpensiveness of their work are those so-called "specialists" who are in fact unscrupulous quacks and are condemned as unethical by the rest of the profession. It is perhaps through unwise advertising by engineers themselves that the public has become accustomed to thinking that engineering costs should average about 5 per cent without regard to their character.

LETTERS TO THE EDITOR

Gasoline Tax Fairest, Says H. G. Shirley

Sir: I read Mr. Mehren's article on p. 4 of the July 1 issue of *Engineering News-Record* with a great deal of interest. I noted carefully the recommendation for the abandonment of the gasoline tax by the road authorities of Great Britain. Personally, I think the fairest tax that can be levied is a gasoline tax, for the man that uses the road the most pays the most, and this looks equitable and fair.

The question as to the method of levying this tax is one that presents quite a number of problems and has greatly deterred putting into effect such a tax in this country. I am firmly convinced that the taxes such as privilege tax, license tax, property tax, and now resignation tax on motor cars should be eliminated and there should be one flat tax to cover the entire field. I feel that a proper gasoline tax would greatly simplify the entire matter and relieve the motor vehicle owners and users of much worry and trouble they are put to unnecessarily in the judgment of the writer. We are suffering very much in this country for the want of a uniform vehicle law and a uniform vehicle tax. I feel that if it is not worked out on a gasoline consumption basis it should be worked out on some logical basis, and that one tax should suffice and be of such amount as would properly provide for the maintenance of the highways.

H. G. SHIRLEY,
Washington, D. C. Secretary, Federal Highway Council.

New York City's Growth

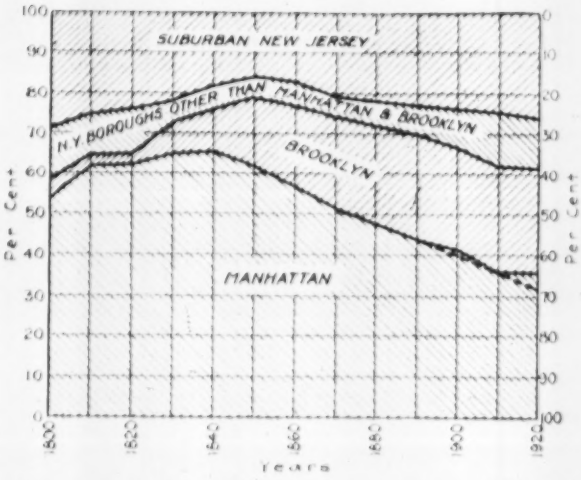
Sir—The editorial note in your issue of June 10 entitled, "The Largest City," seems to be written from the wrong viewpoint. Increasing the population of New York and other large cities parallels the decrease in population in the rural communities. It seems to me that the unprecedented gain for a decade in city population is more a matter for grave concern than applause. What will it profit the country to boast of the largest city in the world, when we have such a large untenanted farm land area, so vital to the immediate and future subsistence and welfare of the nation? With vast farm land areas going unplanted, and with millions of fertile acres without crops, there may be very little consolation in the remarkable increase in New York and other city population. G. E. WARREN,
Chicago. Manager.

[The sole intent of our note was to show New York's present rank in population. The flow of rural population to the cities and its effect upon agricultural production is another story. Doubtless a large percentage of New York's 854,000 increase in population came from cities large and small rather than from farms.—EDITOR.]

Sir—Referring to the comment and surprise indicated in the public press over the population of New York City, and its constituent boroughs, as announced by the Director of the Census, there need be no surprise as the announced figures indicate what has long been predicted by students of the movement of population in cities. Claims that the census figures must be wrong are freely made. While there probably may be errors, these are not likely to be of sufficient magnitude materially to affect the ultimate result.

The accompanying diagram indicates the relative percentage of population in the area occupied by the present boroughs of the city, and in the corresponding tributary communities in New Jersey from 1800 to 1920. This diagram (up to 1910) first appeared in a paper on "City Passenger Transportation in the United States" presented by the undersigned to the Institution of Civil Engineers in 1913.

A study of this diagram indicates that the relative population of Manhattan increased up to 1840 and since then has steadily been decreasing. In fact, if it had not been for the war retarding the normal development of the city the relative population of Manhattan would have been still less, as indicated by the dotted line in the diagram.



RELATIVE PERCENTAGE OF POPULATION OF GREATER NEW YORK AND SUBURBAN NEW JERSEY
Based on the United States Census

A quotation from the paper above referred to follows:

"In the early days the city was confined to the lower end of the Island of Manhattan, now also the Borough of Manhattan, and the growth was northward within the limits of the island. From 1800 to 1850 between 55 and 65 per cent of the population of what may be called the Metropolitan District of New York was confined to the Island of Manhattan. With the development of steam-propelled ferries in the third decade of the nineteenth century the growth of Brooklyn and the towns in New Jersey was much more rapid than that of the central city, so that at the present time only about 35 per cent of the population of the greater city is in Manhattan. This is indicated graphically in the accompanying diagram, and if the tendencies indicated by the curves in this diagram are continued in the future, the Borough of Manhattan will soon cease to lead the others in population and will become a social, commercial, shopping, and amusement center, with a relatively small sleeping population. This tendency is not confined to New York but is characteristic of most modern cities, in which the central area is decreasing in population as the transportation facilities are improved; the tendency being for the city to segregate into areas devoted almost exclusively to commerce, amusement, manufacturing and residence. The census of 1910 indicated that four of the central wards of Manhattan, and five wards in Brooklyn, had lost population in business and manufacturing districts. On the other hand, of the increase of 483,000 in the population of Manhattan in the preceding ten years, 330,000, or 68 per cent, was confined to a single ward in the north end where improved transportation facilities have been provided; and, further, while the population of the city as a whole had increased 39 per cent in that decade, the population of the borough of Bronx had increased 115 per cent in the same period, owing to the extention of the subway."

Engineers who have been studying city planning and transportation have been looking forward to the time when most of the city population will work in the central areas but live in garden communities in the suburbs, which will be a great improvement from the medieval city conditions of living over one's shop, from which we are emerging.

This transition has been checked by the post-war conditions, making it impossible at present to continue the construction of transit facilities, but sooner or later, city development will be adjusted to these new conditions and

the construction of transit facilities and the centrifugal movement of population be resumed to the increased comfort and advantage of all.

GEORGE D. SNYDER,
Consulting Engineer.

New York City.

Free Engineering Advice

Sir—To assume the attitude taken in the column headed "Free Engineering Advice" in the *Engineering News-Record*, July 1, 1920, p. 21, is to take a very narrow view of the engineering profession. Disinterested engineering advice such as comes from the investigations of the U. S. Reclamation Service, the Bureau of Standards, the Geological Survey, etc., and from the research laboratories of the nation's universities should be encouraged.

The same is true of the researches of the manufacturers who are constantly endeavoring to improve as well as to sell their product. To oppose the free distribution of the results of these investigations, just because some one may be losing a fee, is to take a labor union view; is to offer poor recognition of merit; is to discourage a service par excellence. Where would the engineering profession be without its researches in science? What private firm could afford to make the thorough and extensive geological and hydrometric surveys as carried out by the Government? What individual drainage district could or would make an extensive, thorough, and comprehensive study of the entire stream extending through several states?

Moved by a sordid spirit, perhaps one might feel that the broadcast distribution of engineering facts and data would curtail his business. But in engineering as in any other business, the more publicity, the more propaganda, the better. There is no more danger of losing a fee through the distribution of a Government bulletin, or a steel handbook, than there is through the sale of the engineering journals at the newsstands. Until the layman has seen a few samples of real engineering and until he realizes what risks he may be taking without the services of an engineer does he even think about an engineer? In fact, the average farmer on a drainage district, say, doesn't even know why he needs an engineer until he gets interested in a few Government bulletins.

WILBERT BERNHARDT.

Jackson, Mich.

What Canal Freight Carriage Costs the People of New York State

Sir—The following reports for the year ended June 30, 1918, contain considerable data that is of interest in connection with the question as to whether the New York State Barge Canal will prove to be an economic success: Report of the Comptroller, Report of the Comptroller on the Expenditures of the Canals, Report of the State Superintendent of Public Works for both 1918 and 1919.

Figures given in the tabulations on p. 342 to 346 inclusive in the first mentioned report, and on p. 131 of the second report show that from 1905, when work on the enlarged canal was begun, to 1918 inclusive, the total cost for bond charges, maintenance and operation was $111,472,796.26; deducting $13,270,196.66 for interest received on bank deposits makes the net cost of the entire canal system but not including construction, for that period $98,202,599.60, while the tonnage carried was 35,743,270 tons, making the average cost per ton to the taxpayers of the state $2.75.

From the same tabulations it can be shown that it cost the state $11.50 per ton for the 1,159,270 tons carried in the fiscal year ending June 30, 1918.

Even if the Erie Canal had carried the 10,000,000 tons which the State Engineer said it could carry, and in addition the 491,896 tons, which the branch canals carried, the cost per ton for the year would have been $1.28.

Now, even if the canal had prevented said rates from being materially higher, which Mr. Wotherspoon, the then Superintendent of Public Works, said the canal would do, and which did not prevent them from being 40 per cent higher than the canal rates, would not $1.28 per ton, be a pretty large price to pay for that result, to say nothing of the $11.50, which it actually cost for the tonnage transported in 1918?

According to figures given in *Engineering News-R* Feb. 20, 1920, and April 24, 1919, the national Gover expended $4,091,800 for equipment for the New York

In connection with this large expenditure for equip by the national Government, the following extracts fro 1918 Report of the Superintendent of Public Works pertinent to the question of whether the canal will pro be an economic success.

On p. 19: "Before the Federal Government took hold, th was carefully investigated by the National Committee on I Waterways, and while several companies at that time c a corporate existence, none were ready to actually engage in ness without considerable financial aid from the goverm * * *

On p. 20: "No undertaking dependent largely on governm aid can be permanently successful. It is therefore of the uti importance to the future of the canal, that freight carrying c panies should soon be in operation. * * *

On p. 21: "The ultimate success of the improved system dep entirely on whether energetic and able men, with sufficient capi at their disposal will enter the field. * * * Surely a suffici number of enterprising citizens, who recognizing the opportuni for a profitable undertaking, will take advantage of them."

The writer believes that when Mr. Wotherspoon refe to the ultimate success of the canal he means an economic success, but as the new and enlarged Erie Canal and branches has been paid for by the State of New York, and as the national Government found it necessary to extend financial aid of more than $4,000,000 for equipment, was it not because "energetic and able men with sufficient capital at their disposal" had not entered the field to any great extent, and does it not therefore follow, according to Mr. Wotherspoon's statement above quoted, that the Erie Canal, even with the large amount of aid extended by both state and national Government, has not and never will be permanently or even temporarily an economic success?

It seems to the writer that Mr. Wotherspoon answered this question affirmatively, when he said in his report quoted above, "No undertaking dependent largely on Governmental aid can be permanently successful."

That energetic and able men have not entered the field to any great extent is shown by the following statement made by Edward S. Walsh, the present Superintendent of Public Works, in his report for the year ending June 30, 1919:

Except for a few so-called "new" type barges the boats in service were the old Erie Canal or "240-ton" type which were operated by their individual owners.

During the navigation season of 1919, under somewhat unfavorable conditions as the type of boats used were not designed for Barge Canal navigation, conclusive evidence of abnormally low cost of transportation on the improved canal was revealed. A steamer and consort carrying cargo for New York to Buffalo accomplished the trip in a little more than four days at an operating cost of 1.21 mills per ton mile. The cargo paid a rate of $1.50 per ton, thus the net earning of the trip was more than $1 per ton.

There can be no question as to the ability of the canal transportation companies to earn a handsome profit.

Mr. Walsh evidently means a handsome profit to the boat owner, which is possible because the taxpayers bear all operating costs and bond charges. Now, what would these items amount to for the trip from New York to Buffalo?

The writer has not the data for 1919, but if the trip had been made in 1918, the reports of the Comptroller and Superintendent of Public Works for that year contain sufficient data to determine what the cost to the taxpayers would have been. The first mentioned report on p. 11 gives the total canal boat mileage as 576,731 miles, and the second report shows that the net cost of the canal to the taxpayers was $13,333,943.

By dividing this last sum by 576,731, it will be found that the average cost per boat mile would have been $23.22 if the trip had been made in 1918 instead of 1919.

As the distance by the canal from Albany to Buffalo is 363 miles, the total cost of the trip to the taxpayers would have been $23.22 × 363, or $8,428.66.

It seems to the writer that this trip, which Mr. Walsh gives as evidence of "the ability of canal transportation companies to earn a handsome profit" and "of the abnormally low cost of transportation" was possible only because of the large part of the cost paid by the taxpayers.

The writer would like to have some advocate of the canal transportation explain how, taking into consideration the figures given above, the Barge Canal and branches can prove to be an economic success.

W. G. WILKINS.

Pittsburgh, Pa.

HINTS FOR THE CONTRACTOR

Stocking Stone With Conveyor Loader

BY HENRY H. WILSON
President Managing Partner, Winston & Co., Muncy, Pa.

IN THE construction of state highways at Muncy and Picture Rocks, Pa., it was necessary, on account of the uncertainty of future shipments, to stock crushed stone in advance of the laying of concrete pavement. For this purpose a conveyor loader, supported on a cribbing of railroad ties was used, as shown in the

FIFTY TONS STONE PER HOUR HANDLED BY METHOD SHOWN

accompanying illustration. About thirty cars were stocked at each of the above-mentioned places, the stone being handled direct from elevator to stockpile at a very reasonable cost. With an elevator, it was possible to stock as high as 50 tons per hour by this method. By moving the discharge end of the loader radially it would have been possible to stock a much larger amount than was actually handled.

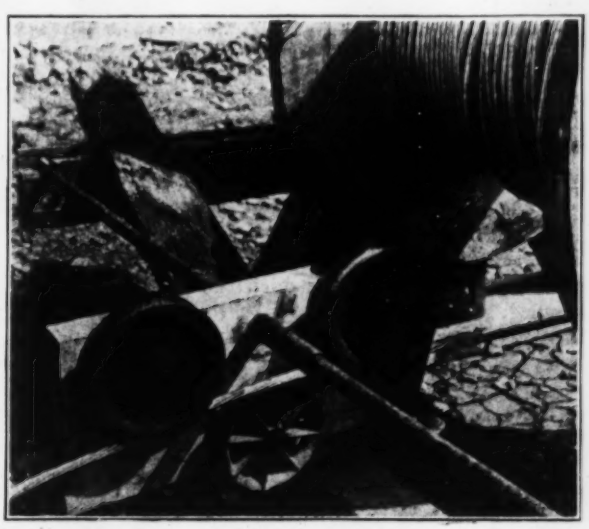
Questions Which the Drilling Boss Should Ask Regularly

EFFICIENT superintendence of rock drilling operations requires constant and systematic interrogation by the superintendent or foreman who is directing the work. Based on mining experience, a list of questions is given by Edwin H. Higgings in the *Engineering and Mining Journal* of June 26, 1920, as follows:

(1) Are the drills of suitable type for the ground? (2) Is the drill equipment standardized as far as possible? (3) Are facilities for drill repair so systematized that it is unnecessary for the men to go to surface to secure parts or to have repairs made; (4) As a preventive of lost time, are the men at the face well supplied with gaskets for drill connections, good wedges and foot blocks, oil cans or cadgers and a box for the storage of tools and extras? (5) Are a few extra water tubes kept on every working level? (6) As a time saver, have the men tried carrying with them an ordinary hat pin for dislodging obstructions in the water tube? (7) Is the jackscrew nut (of the column bar) supplied with grease at intervals? (8) Is 1-in. air hose used with Turbo, Leyner and DR-6 machines? (¾-in. hose is too small). (9) Are 3½-in. columns used with modern water-hammer drills? The old 4-in. or 4½-in. bars should be discarded on account of their weight. (10) Do the men realize the importance of properly lubricating machine drills? (Grease for the chuck end and castor oil or liquid grease for the rear lubricators). (11) Is it realized that for 1¼-in. round hollow steel the shank length should be 3⅛ in., and for ⅞- and 1-in. hexagon steel the shank length should be 3½ in.? The water-hammer drill of today has a short piston travel. Hence, when lugs or collars become badly worn they allow the steel to enter the machine too far, thereby "short-stroking" the hammer. Likewise, when the end of the shank becomes worn shorter through constant use it does not enter the machine the proper distance and the hammer cannot deliver its full blow. In both cases efficiency is greatly impaired. Hammers and anvil blocks will soon be destroyed if the bearing surface of the shank end of the drill is allowed to become badly battered or chipped. (12) Are the side rods on the machines kept uniformly tight? (3) Is improvement possible in the number, pointing or depth of drill holes? (14) Is sufficient air pressure maintained at the drill? (15) Is there undue breakage of drill steel? (16) Is the proper type of bit being used for ground drills? (17) Are the sharpening and tempering satisfactorily done? (18) Is there a man especially qualified to repair drills?

Home-Made Device Removes Reel Kinks From Wire Rope

REEL kinks are being successfully removed by the simple device illustrated, in preparing wire rope for concrete block revetment at vulnerable places on the improved Miami River channel at Dayton, Ohio. This rope, cut to lengths of 20 ft. or more, has to be threaded through holes in precast concrete blocks and it is important that it shall lie straight to facilitate the threading operation. As indicated by the illustration the reel of rope is suspended on an axle on a timber frame so as to unwind from the bottom. In front of the reel three pulleys attached to an axled plank, as



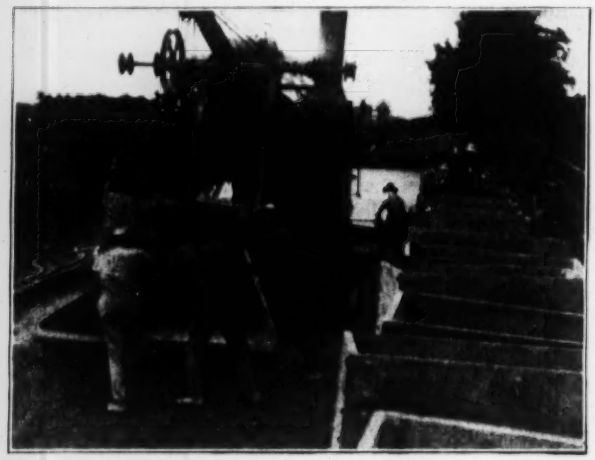
WIRE ROPE STRAIGHTENED BY THREE PULLEYS STAGGERED

shown, constitute the straightening device. The entire arrangement, fashioned of material on the job by Price Bros., Dayton, Ohio., contractors, cost very little and has served its purpose excellently. The Dayton channel improvements are a part of the flood protection works of the Miami Conservancy District.

Paver Places a Batch of Minute-Mix Every 75 Seconds

SYNCHRONIZED mixer operation was an important factor in securing an unusually high rate of speed in building concrete road near Oliver, Ill. The complete cycle of mixer operations, charging, mixing 1 min., and discharging, averaged between 1 min. 10 sec. and 1 min. 12 sec. A length of 744 ft. of 16-ft. road, 8 in. thick was constructed according to the specifications of the Illinois Division of Highways in 9½ consecutive hours. A four-bag batch with a ¾-cu.yd. Smith paver was employed. It is to be noted that the output given is the high rate for a day and not an average speed.

The action of the mixer was so synchronized that the discharging time exceeded the skip raising time by



BATCH-BOX SWING TIMED EXACTLY WITH LOWERING OF SKIP

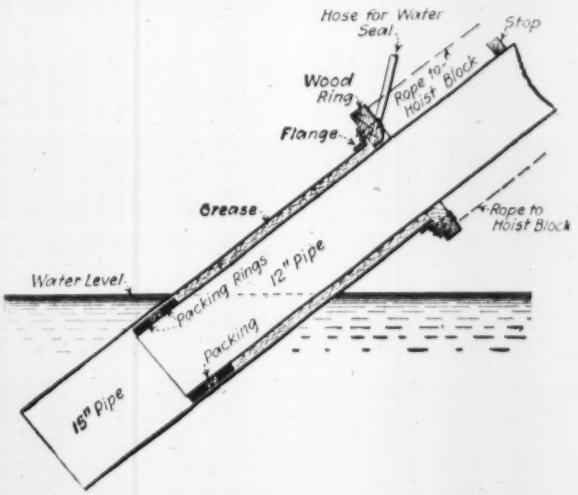
about one second. This means that the operator began to raise the skip at the same time he pulled the discharge lever and the drum was completely emptied by the time the skip was fully raised. It was this fact, principally with the perfect co-ordination of the supply crew, that made possible the record.

Another fact that contributed materially toward the record was the ease with which the batch boxes were handled. The derrick operated on the same cable as the skip and as the loaded skip was raised the derrick lowered and was hooked onto a loaded batch-box. While the skip was being lowered the batch-box full of material was being raised and swung into position, so that by the time the skip reached the ground this batch was ready to be dumped into it. This allowed ample time, while the material in the drum was being mixed, to spot the batch-box cars in position for the next batch.

The mixer was supplied by two gasoline locomotives each pulling ten cars, or twenty batches, with a run of slightly over a mile. At no time during the day was there any delay in waiting for the train to pull into p[osi]tion. During the 9½ hours that the mixer ran, 22 t[rai]loads, carrying 440 batches, were used. The ent[ire] crew was 35 men, including the men at the material b[in] the cement house, on the industrial railroad, on [the] grading and sub-grade, at the mixer, and on the tamp[ers]. The contractor was Allen J. Parrish, Paris, Ill.

Slip-Pipe Suction Reduces Liability of Choking

TENDENCY to choke at the suction, in pumping from a sump to construct the hydraulic-fill dam at Lockington for the Miami valley flood protection work,



SUCTION PIPE ARRANGEMENT FOR DREDGE PUMP

was greatly decreased by a slip-pipe arrangement devised on the job and illustrated by the accompanying diagram. At this dam material from the borrow pit is sluiced to the sump and occasionally there is a rush of solids into the sump which, for a few minutes, is beyond the capacity of the pump to handle and the sump is filled. In such instances the 12-in. suction pipe is liable to choke and become plugged. This means a shut down and much disagreeable work to clean out the plug. With the slip-pipe arrangement improvised, when the sump begins to fill the operator, by means of the hoist blocks, pulls the 15-in. pipe up out of the accumulation of solids and keeps it clear until the delivery from the sluice slacks down. Then the slip-pipe is eased back until the sump is cleared and solid material is being delivered in normal volume by the sluices. It is found that since the slip-pipe has been used delays due to plugged suction pipes have been materially reduced. The Lockington dam is a unit in the flood protection works being constructed by the Miami Conservancy District.

Arthur E. Morgan is chief engineer, Chas. H. Paul, assistant chief engineer and C. H. Locher, construction manager respectively, of the Miami Conservancy District. Barton M. Jones is the division engineer at Lockington Dam.

City Planning Commission at Los Angeles

A City Planning Commission of 51 men and women has been created by the City Council of Los Angeles.

NEWS OF THE WEEK

New York, July 29, 1920

Discuss St. Lawrence Waterway Project

Oratory Loses in Contest with Consideration of Economic Facts on $750,000,000 Improvement

(Reported for Engineering News-Record by Dr. F. H. Newell)

An encouraging sign of the times is that a waterways congress has been held and governmental appropriation urged for a project on its engineering and economic merits. This is in strong contrast with the so-called "pork barrel" claims from the localities where the appropriations were to be expended under old-time River and Harbor Acts.

The president of the Great Lakes-St. Lawrence Tidewater Association, H. C. Gardner, is an engineer; the program for the meeting in Detroit in cooperation with the Board of Commerce, held July 21-24, was arranged largely by engineers and participated in by economists, not, of course, to the exclusion of the politicians, but to a degree sufficient to afford real information concerning the merits of the scheme.

The object of the meeting was largely educational, to attract public attention and to diffuse information concerning the importance and practicability of providing a waterway or channel in the St. Lawrence River such as to permit ocean-going vessels to come up into the Great Lakes.

This enterprise has been commented upon favorably by Charles Whiting Baker, in his series of articles in *Engineering News-Record*, January 1 to 29, 1920. The papers and discussions at Detroit amplified many of the points concisely stated by Mr. Baker and brought out clearly the fact that while this great international enterprise is one which should be undertaken jointly by Canada and the United States, yet it has sufficient merit to justify the assertion that private capital can be found adequate to build the hydro electric works and at the same time provide for navigation needs.

The belief is strong, however, that this great undertaking, involving both navigation and power development and which, as described by Gardner S. Williams, may cost upward of $750,000,000, should not be left wholly to private enterprise, but should be initiated and financed in larger part the two governments concerned.

Definite engineering data on the alternative projects and costs were not available at the time of the meeting, because of the fact that the International Joint Commission, having the

(Continued on p. 237)

Railway Engineers Not Included in Labor Board's Award

Assistant engineers and draftsmen in railway service were not granted an increase in compensation under the Railway Labor Board's award of July 20. A bulletin of the American Asso tion of Engineers quotes this statement from the Board: "Civil engineers as such had no submission presented for them and hence no question as to them has been decided." Several railway sections of the A. A. E. have initiated negotiations with the railway managements for salary adjustments and if these fail to produce satisfactory results the association will appeal to the Labor Board for a hearing.

New Financial Basis for Chapters of A. A. E.

An order promulgated as of Aug. 1 by the board of directors of the American Association of Engineers and effective Sept. 1, provides for a new percentage of income allotted to the chapters of the association. Chapters with 600 or more members will receive 60 per cent of the entrance fees and dues received from members of the association residing in their respective territories. Such chapters will constitute one of four classes into which chapters are to be divided on the basis of membership and assumption of duties. This class of chapters will handle employment service, qualification committee work, and other local activities. They will maintain offices and paid staffs.

Chapters comprising the other three groups will receive a percentage of income carrying from 50 per cent to 35 per cent, depending upon the size and duties assumed. Chapters with from 350 to 600 members will get 50 per cent and will maintain offices with paid secretaries or managers. Chapters with from 100 to 350 members will get 40 per cent of income and will have paid stenographic help. Chapters with less than 100 members will receive 35 per cent of the income and will function on volunteer help only.

This order will be effective unless protested by chapters of the association comprising 1,500 or more members. The same order carries with it an increase of dues for all members except student members to $15 per annum, an advance of $5 over present dues, effective Jan. 1, 1921. It is expected that at least 20 chapters of the association under these provisions will be able to engage full time paid secretaries. In addition to the five district secretaries, the association already has paid employees in several chapters.

Constitutional Amendments at Am. Soc. C. E. Convention

Five Proposals on Dues, Local Sections and Number of Directors To Come Up for Discussion

At the Portland, Ore., convention of the American Society of Civil Engineers, Aug. 10 to 12, five recently proposed constitutional amendments are to be discussed. They deal with matters that have been very active in society circles, including local sections and the allocation of all members to such sections; the election of directors by the members resident in the respective districts, and the relation of the secretary to the Board of Direction. Increase of membership dues is also proposed. Two minor improvements are proposed in separate amendments.

One of the amendments is presented by the Questionnaire Committee and purports to crystallize into law the opinions on internal affairs expressed by the membership of the society in the questionnaire held in March and April of the current year. R. H. Humphrey, member of the Development Committee and later chairman of the Joint Conference Committee, is among the signers of another amendment, closely similar to the Questionnaire Committee amendment but differing in some vital details.

According to the requirements of the constitution, the amendments must be submitted to letter ballot of the membership as amended by the convention or (if not amended) in their original form. However, in case the convention refers an amendment to a special committee, action is deferred until the annual meeting in January, at which the committee must submit its report. The five amendments, arranged in the order as printed by the society (this being according to date of receipt at the secretary's office), are summarized in the following:

A—Percival Clow, C. E. Haywood, W. S. St. John, W. J. Heiser and A. W. A. Eden propose increasing the annual dues for all members to the amount now paid by resident members (corporate members $25, associates $15, juniors $15), and striking out the present provision for additional dues to be paid by resident members. Life membership dues are revised.

B—The Committee of the Board of Direction appointed Jan. 22, 1920 (A. N. Talbot, Leonard Metcalf, R. A. Cummings, M. S. Ketchum, John C. Hoyt, C. C. Elwell, Harry Hawgood) to prepare a questionnaire to the membership on the Development Committtee's re-

port and to formulate suitable amendments from the results of the questionnaire, now proposes a change in the annual dues, a change in the statement of the society's objects, establishment of compulsory local sections, and nomination of directors by districts. The committee states that according to legal advice election of directors by districts would not be lawful, as the New York corporation law contemplates that directors shall be elected by the votes of all members.

What Five Am. Soc. C. E. Amendments Would Accomplish

A. DUES—Abolish the distinction between "resident" members and others by raising the dues for the latter, all dues becoming: for corporate members $25, for associates $15, for juniors $15—[Clow, Haywood, St. John, Helser, Eden].

B. OBJECTS; DUES; LOCAL SECTIONS; NOMINATIONS — (a) Add to objects of the society as a secondary object, co-operation in important public movements. (b) Increase the dues of non-resident corporate members to $20, non-resident associates to $15. (c) Provide for establishment of local sections to comprise the entire membership (member's choice, otherwise assignment). (d) Provide for nomination of directors (18, as at present) by the local sections of the several districts; nomination of other officers by representatives of the districts as chosen by the local sections.—[Talbot, Metcalf, Cummings, Ketchum, Hoyt, Elwell; the Questionnaire Committee named by the Board of Direction last January and instructed to propose amendments corresponding to the result of the questionnaire.]

C. HONORARY MEMBERS—Change requirement for election of honorary members from unanimous vote of board to vote of two less than whole board. Eliminate provision for change in composition of board when voting on honorary members.—[Talbot, Metcalf, Cummings, Davis, Pegram, Curtis, Crocker, Marx, a committee appointed by the Board of Direction in June, 1919, to nominate cand'dates for honorary membership.]

D. ELIGIBILITY TO OFFICE—Make members of the nominating committee ineligible to any other office during their service.—[Lucas, Holland, Gilman, Rumery, Reeves.]

E. LOCAL SECTIONS; BOARD OF DIRECTION; SECRETARY; RESIDENT OFFICERS; NOMINATIONS; ANNUAL CONFERENCE — (a) Provide for establishment of local sections to comprise the entire membership (member's choice, otherwise assignment). (b, c) Reduce membership of Board of Direction from 30 to 23, by reducing directors from 18 to 14, past presidents from 5 to 3, and removing secretary from Board. Allot two directors to District 1, and one to each of other twelve districts. (d) Eliminate requirement that one vice-president and six directors must be "resident" members. (e) Provide for nomination of directors by the local sections of the several districts; nomination of other officers by representatives of the districts as chosen by the local sections. (f) Create an annual conference of the representatives of the local sections, which, besides making the nominations for officers, is to consider the welfare of the society and its members and report thereon to the Board of Direction.—[Franklin, Easby, Quimby, Humphrey, Frommer.]

The statement of the object of the society as contained in the present constitution is amplified by adding a secondary object "to co-operate in important economic, industrial, and civic movements in which the members of the society are particularly well qualified to advise the public." Membership dues are to be increased to $20 for corporate members, $15 for associates, and $10 for juniors, and $5 additional for resident corporate and junior members.

One or more local sections are to be established in each of the thirteen districts to "stimulate active interest of their members by giving reasonable representation upon the active committees, by encouragement of discussion of the general problems of the society, by arranging excursions to works of engineering interest, and by promoting social intercourse." Every member must join a section or he will be assigned to one. Each local section chooses a representative for nomination of officers, and the representatives within a given district nominate one or more candidates for director to represent that district, which are then balloted on by the members in the district. Subsequently all the local section representatives meet as a nominating committee and nominate officers for the society for the coming year, including on the ticket the candidates for director selected by the ballots of the several districts. Voting on this committee is to be in proportion to membership.

C—A modification in the method of electing honorary members is proposed by a committeee appointed by the Board of Direction a year ago to nominate honorary members, this committee consisting of A. N. Talbot, Leonard Metcalf, R. A. Cummings, Arthur P. Davis, George H. Pegram, Fayette S. Curtis, H. S. Crocker, and C. D. Marx. The present constitution requires unanimous vote of the Board to elect honorary members, but under the amendment a vote of two less than the full Board will elect.

D—Members of the nominating committee are to be ineligible for other office during their term of service, under an amendment proposed by G. L. Lucas, C. M. Holland, Charles Gilman, R. R. Rumery, and W. F. Reeves.

E—Local sections and nomination of directors are dealt with in a way slightly different from that adopted by the Questionnaire Committee (Amendment B, above), in amendments proposed by B. Franklin, William Easby, Jr., H. H. Quimby, R. L. Humphrey, and Charles Frommer. These also propose to establish an annual conference of representatives of local sections, "to consider the welfare of the society and its members and to report thereon to the Board of Direction." No change in dues is proposed. The representation of District 1 on the Board of Direction would be cut down to two, reducing the number of directors to fourteen, and the number of past presidents on the Board would be reduced from five to three. At the same time the secretary would be removed from the Board, and the Board of Direction thus left with a membership of 23 (at present thirty).

Under these amendments membership in local sections is obligatory. Representatives of the local sections [illegible] each district meet as a district [illegible] to nominate candidates for direct[illegible] selection from among these candid[illegible] being by letter ballot of the mem[illegible] within the district. Subsequently [illegible] representatives meet in annual con[illegible]ence of representatives of local s[illegible]tions, to nominate officers for [illegible] society and to consider the welfare [illegible] the society as already noted.

Chicago Bascule in the "Movies"

An opening ceremony for the Chicago River bascule bridge of the St. Charles Air Line R.R. (see *Engineering News-Record* of Dec. 25, 1919, p. 1056) was staged June 23 for the benefit of a moving picture concern, a number of engineers being present. A woman fireman from the engine of the special train of the Illinois Central R.R. drove a so-called "last spike," the director of the scene apparently assuming track work to be part of a fireman's duties. Then the engine proceeded across the bridge, with a woman sitting on the bumper beam to cut a ribbon barrier with a pair of nice large office shears. It may be explained that the bridge has been in service for some time.

Advise Street Cleaning and Refuse Collection by Philadelphia

A change from contract to municipal street cleaning and the collection of garbage, ashes and rubbish at Philadelphia is recommended by a committee of three appointed by Mayor Moore on authorization by the City Council. The committee consisted of E. B. Morden, chief of the Bureau of Street Cleaning; James W. Follin, engineer, Philadelphia Bureau of Municipal Research, and J. H. Neeson, principal assistant engineer, Bureau of Highways. Mr. Neeson recommends postponement of the change to city collection of ashes and rubbish until Jan. 1, 1922, but the others advise that it take effect Jan. 1, 1921. The recommendation for city collection of garbage is conditioned on obtaining bids for disposal separate from collection. The committee advises that bids be invited on or before Aug. 1 for garbage disposal on alternate plans for one- and five-year contracts; also that the Bureau of Street Cleaning be expanded to "include an adequate engineering personnel to study continuously and to plan improvements in methods of doing work, and such other personnel as is requisite to carry on intensive continuous educational and law-enforcement campaign." Garbage disposal by feeding to hogs is favorably mentioned in the report.

Since the report was submitted, Col. Morden has resigned as chief of the Bureau of Street Cleaning and Mr. Neeson has been made acting chief. It is reported that Mayor Moore has advised that bids for street cleaning for the calendar year 1921 be secured before Oct. 1.

Municipal Improvements Meeting at St. Louis Has Local Support

Local engineers, contractors and others interested in making a success of the convention of the American Society for Municipal Improvements at St. Louis, Mo., Oct. 11 to 15, have organized six committees for the purpose, with a plentiful representation of the municipal engineering and other city departments, including W. W. Horner, vice-president of the society and chief of the St. Louis Division of Sewers and Paving. Henry W. Kiel, mayor of St. Louis, has sent out a general call to mayors and municipal officials all over the country to attend this meeting, and it is expected that special conferences will be arranged between mayors of various classes of cities. E. R. Kinsey, president of the Board of Public Service, has sent a similar invitation to over three thousand engineers in various parts of the country.

St. Lawrence Waterway

(Continued from p. 235)

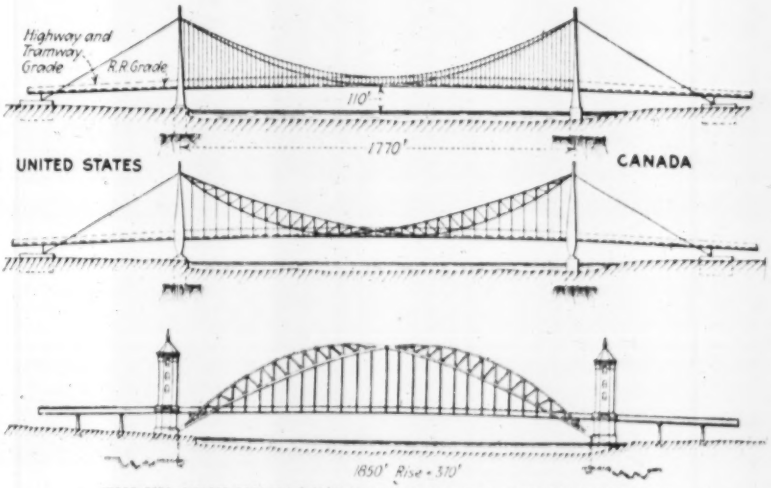
investigation in charge, had not yet received the reports from its engineering staff. There was no doubt expressed, however, by the well informed economists and engineers but that the results would justify any probable cost, also that the waterway thus made available would contribute for all time to the prosperity of the cities along these great inland seas. With a deep channel and with dams and locks overcoming the difficulties in the St. Lawrence River, increasing the navigable depth from 14 to 26 ft., the inland cities would receive facilities for oceanic shipping equal to those of the cities on the Baltic or Black Seas.

Especial emphasis was placed on the need of immediate action because of the increasingly difficult conditions resulting from congestion at the available sea ports, especially at New York. The opposition of this latter city and of the State to the St. Lawrence project has been just strong enough to arouse thoroughly the entire Great Lakes region, and to make it apparent that New York will not be able to obtain any favors nationally for its projects unless its representatives assume a broader and more unselfish attitude toward the development of the resources of the nation.

The choking of commerce at Buffalo and New York for the benefit of these cities, already dwelt upon by Mr. Baker in his article, was emphasized in many ways. At the same time the fact was brought out by Dr. Roy S. MacElwee, director of the United States Bureau of Foreign and Domestic Commerce, that, from the standpoint of sound economics, a large proportion of the ocean-going vessels at present in use or probably to be used in the future, could pass up into the Great Lakes and could discharge and obtain loads far more economically than at the congested port of New York.

Detroit Bridge Prospects Bright

At a meeting of twenty-five Detroit and Windsor capitalists held July 15 steps were taken to speed up the progress of the enterprise for a bridge across the Detroit River to connect the two cities. Studies for such a crossing have been carried on by Charles Evan Fowler, constructing engineer, for the past eight months, funds for the investigation being supplied by the interests represented at the latest meeting. On presentation of his report the meeting decided to go ahead with the remaining preliminaries looking toward immediate construction, and committees were named to direct the work.



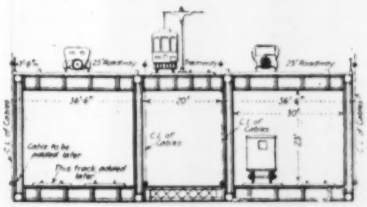
THREE PRELIMINARY DESIGNS FOR DETROIT-WINDSOR BRIDGE; SUSPENSION TYPE FOUND PREFERABLE FOR ECONOMY AND SPEED OF CONSTRUCTION

It has been found that the best location for the bridge is just above 24th St., Detroit, where a span of 1,770 ft. is practicable. A highway bridge here would cost nearly twelve millions, while the addition of accommodations for railway trains (four railway tracks, two street-car tracks, two 28-ft. roadways, two 7-ft. sidewalks) would make the cost $28,000,000.

An understanding has been reached with the Great Lakes Carriers Association that for a clear span between harbor lines the vertical clearance should be 110 ft. at the center and 100 ft at the sides; this will provide for all wireless masts for lake or ocean craft. At the pier locations, rock is found at 90 to 100 ft., and pneumatic foundations are to be used.

Traffic studies showed minimum yearly totals exceeding ten million passengers, 500,000 autos, 70,000 auto trucks, and 15,000 teams. With the bridge in service the estimated increases in five years are 100 per cent, 600, 600 and 600 per cent for these four classes of traffic. Over one and a half million freight cars cross the river, and it is believed certain that over a million could with economy use the bridge. Approximate estimates for the cost of tunnels of capacity equal to that of the bridge give figures of more than $60,000,000 for the 24th St. site and $80,000,000 for a site at Woodward Ave.

Several of the preliminary study designs are shown herewith. The cable suspension bridge shown by the upper elevation is considered cheapest and safest in erection.



PROPOSED DOUBLE-DECK ARRANGEMENT OF DETROIT BRIDGE SHOWN IN CROSS-SECTION

Shipment of Water Purification Chemicals Delayed

Owing to delays in the shipment of chlorine, alum, and other materials used in water treatment, health officials of New York, Pennsylvania, and four other states recently applied to the U. S. Public Health Service for its aid. Notwithstanding a request by the Secretary of the Treasury to the Interstate Commerce Commission, and representations of the Surgeon General, the commission, according to Public Health Reports of June 25, deemed "it inadvisable to give general priority to these essentials in public health work, but is willing to act upon requests, giving full particulars, in cases of individual shipments, [and] to use its best efforts to expedite the movement of such shipments." The Public Health Service therefore suggests that all requests for the expedition of water purification chemicals be sent direct to the Interstate Commerce Commission, giving full particulars for each individual shipment "including the name of the railroad and the shipping and destination points."

Schenectady Bridge Foundation and Pier Contract Let

On July 21 the State canal board of New York awarded the contract for foundations and piers of the new Mohawk River bridge to connect Schenectady and Scotia, to the American Pipe & Construction Co., Philadelphia. The total of the bid price is $961,963, which is about 50 per cent above the original estimate for this part of the work, made in 1918. The available appropriation for the bridge is $1,700,000. At present the approaches are being built by Dubois, Bennett & Son, of Schenectady, the total of this contract being about $230,000. Contracts 3 and 4, for arches and paving, respectively, are still to be let.

In order to protect itself against claims arising from the fact that the total present appropriation might be insufficient to build the bridge complete, the canal board has stipulated in the contract that its members shall not be liable to the contractor for any payments.

The bridge is to be known as the Western Gateway Bridge. It will be 4,436 ft. long over approaches, and its main part will consist of 23 concrete arch spans of 106 to 120 ft. clear width, and a 212 ft. arch span over the Barge Canal channel. A description of the bridge with perspective view was printed in this journal June 26, 1919.

May Use Airplanes to Map Texas-Oklahoma Boundary

The vagaries of the Red River in its flow eastward from the panhandle of Texas are affected, the suit now pendred miles to Texarkana has resulted in a dispute between Texas and Oklahoma as to the boundary of these states. Although twelve counties of Texas are affected, the suit now pending before the United States Supreme Court, which will be heard at the December term, affects particularly only twelve square miles. This portion of land is of special significance because over $200,000,000 worth of oil rights are involved.

Extensive engineering and mapping work, contemplated in preparation for the suit, is now being arranged for by Arthur A. Stiles, Texas state reclamation engineer, who has been discussing the matter with the U. S. Geological Survey, the General Land Office and the Air Service of the Army. It is expected that some of the mapping work will be done by airplane through the co-operation of the Air Service.

The expenses of this survey work will be shared probably on an equal basis by the State of Texas and the Federal Government. Ample appropriations for the state work were provided in the recent act of the legislature which placed the technical portions of this problem in the hands of the state reclamation engineer, who was thereby designated to assist the attorney general of Texas in prosecuting the case.

Emblem Chosen for Society of Military Engineers

The Society of American Military Engineers has adopted the emblem illustrated herewith. The shield is symbolic of its policy of national defense. In the center of the shield stands the figure of the Spirit of Victory adopted for the World War Medal. Its feet rest on the cogged wheel, symbol of mechanical engineering, which

EMBLEM ADOPTED BY SOCIETY OF AMERICAN MILITARY ENGINEERS

has its application in war in such a myriad of forms. Electrical engineering is represented by the thunderbolt of Jove held in the eagle's talons. Underlying all is a bastioned fort—the strong point of military defense—representing the constructive skill of the civil engineer applied to military purposes. The entire badge is surrounded by a laurel wreath indicative of past success and future aspirations. Although these three branches of engineering are the fundamentals of military engineering, they by no means cover the entire field of military science, and membership in the society is open to all engineers of suitable military qualifications. Arrangements are being made for the distribution of the emblem among members to be worn as a pin, lapel button or charm.

C. A. Houston, of the Bureau of Engraving and Printing, United States Treasury Department, is responsible for the artistic form of the emblem.

Miss King To Represent A. A. E. at Scientific Congress

At the Pan-Pacific Scientific Congress to be held in Honolulu, Hawaii, Aug. 2-20, the Chicago Chapter of the American Association of Engineers will be represented by Miss Florence King, a consulting engineer and patent attorney of Chicago, who is the only certified woman member of the association. Miss King is sailing at once for Honolulu and will attend all of the sessions of the congress.

During an experience of 25 years, Miss King has been engaged as consulting engineer in machine design and construction, as attorney and as solicitor of patents.

Power Commission Cannot For Own Organization

The new Federal Power Commis must depend on the War, Agricul and Interior Departments to do work that the commission propo according to the following ruling of Comptroller of the Treasury.

"I think it is reasonably clear th the provisions of the Act negative th suggestion of any intent to vest in th Commission authority to build up an organization of employees, either b original appointment or by transfe from other branches of the governmen service.

"The responsibility for the work of this Commission is placed by law upon the Secretary of War, the Secretary of the Interior, and the Secretary of Agriculture, and each of these secretaries is authorized to use the personnel and other facilities of his department to accomplish such work. If the personnel of the three departments concerned is not adequate to perform properly the regular work of said departments and also the work of the Commission, it is for the three secretaries, who are also the members of the Commission, to determine what work shall be accomplished and what shall be left unperformed.

"When Congress provides a lump sum appropriation for the expenses of a commission or board it usually stipulates that the appropriation is available for the employment of personal services, if the employment of such services is contemplated, and specific authorization is required by law if personal services are to be employed by the commission at the seat of government. The comparatively small appropriation made for the expenses made necessary by this Act, contains no such provision, although it expressly mentions other items such as rent and transportation and subsistence. This is another indication that the appropriation for the expenses of the Commission was not intended to be available for the payment of any salaries other than the salary of the executive secretary."

No Changes in Division Heads of Construction Service

Col. Warren W. Whiteside, who has been placed in charge of the construction service in its new status as a part of the Quartermaster Corps, as announced in these columns last week, is a Regular Army officer. A considerable portion of his experience, however, has brought him into direct contact with construction. During the past year, he has been serving with the Construction Division under General R. C. Marshall. He served in France throughout the war with the 89th Division.

Under the new administration the subdivisions of the construction service will remain the same. Major C. L. Corbin is continued as administrative officer; Lt.-Col. L. L. Calvert is con-

...ed in charge of the building divi...; Lt.-Col. F. B. Wheaton, in charge ...the engineer division and Major R. ... Case, the contract division.

The real estate division of the Quartermaster Corps has been added to the construction service as one of its subdivisions. The head of that subdivision is Major Carl F. von dem Bussche.

In order to decentralize, as much as possible, the work of the construction division, district offices have been opened at San Francisco, at San Antonio, and at Washington, D. C.

Society of Military Engineers Selects Officers

At a meeting of the temporary board of directors of the Society of American Military Engineers, held in Washington, D. C., June 2, preliminary organization was perfected. Due to the lateness of the season and to the fact that a period of 60 days is required to call a meeting of the society, it was decided that the organization should continue to function until after the first annual meeting, which is scheduled for the Friday preceding the third Wednesday in January, 1921.

The following officers were elected to serve until the annual meeting: President, Maj.-Gen. William M. Black, retired; first vice-president, Col. William Barclay Parsons, second vice-president, Col. Charles Keller; secretary, Capt. D. L. Weart; treasurer, Major William O. Tufts.

The following directors were named: Cols. F. V. Abbot, F. A. Molitor, George D. Snyder; Lt.-Cols. C. H. Birdseye, A. H. Brooks, J. H. Finney, H. S. Graves, W. W. Kirby, George B. Pillsbury, Glenn Smith, Evarts Tracy, G. A. Youngberg; Majors Percy E. Barbour, P. S. Bond, J. J. Kingman, Max C. Tyler, E. Tufts; Capt. D. McCoach.

The executive committee comprises Maj.-Gen. Black, Cols. Parsons, Keller, Molitor; Lt.-Cols. Brooks, Graves, Major Tufts and Capt. Weart.

The committees are as follows: Development, Major Bond, chairman; Cols. Molitor, Snyder; Lt.-Col. Finney, Major Barbour. Design of Emblem, Lt.-Cols. Youngberg and Tracy. Membership, Lt.-Col. Youngberg, Majors Edwin H. Marks, William J. Shea and Capt. Thomas H. Messer.

American Reconstruction Unit Leaves for France

One of the first officially recognized groups of American engineers and landscape architects who will engage in reconstruction work in the devastated area in France sailed from New York July 8 under the name of the Harvard Reconstruction Unit. The organization consists of twenty members, headed by Reginald Coggeshall, Department of Government, Harvard University, who was appointed by President Lowell to take charge of the unit after it was organized by Robert Buell and Guy H. Lee of the graduate school of landscape architecture at Harvard.

The membership of the unit is made up largely of post-graduate students as follows: Harvard, fourteen; Massachusetts Institute of Technology, two; Columbia, one; Yale, one, and Princeton, one. Almost all of the members are former A. E. F. men. Town planning work in co-operation with the French authorities covering a period of three months has been outlined, the American unit serving without compensation, but with expenses while in France paid by the French Government and the Department of the Meuse to which it has been assigned. Its work will be carried on in the Argonne district. The temporary address of the organization is Harvard Reconstruction Unit, c/o Guaranty Trust Co., 1 Rue Des Italiennes, Paris.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The Engineers' Club of Seattle, Wash., was recently addressed by Col. H. P. Warren, of the Alaska Engineering Commission, in charge of Supply Division at Seward, Alaska. His subject was "The United States Railroad in Alaska."

The Oklahoma Association of Members, Am. Soc. C. E. has been organized, with headquarters at Oklahoma City, and with the following officers: President, H. B. Hinckley; vice-presidents, E. S. Alderman, C. M. Pritchard, E. M. Graham, F. D. Brown, H. F. Layton and M. L. Cunningham; secretary, F. H. Craddock.

The Association of Professional Engineers of Alberta held its first general meeting at Calgary, July 10, which was called for the purpose of completing the organization formed in April by act of the Legislature of the Province of Alberta. The association starts with a membership of more than one hundred practicing professional engineers. The following officers were elected. President, F. H. Peters, commissioner of irrigation, Reclamation Service, Department of the Interior, Calgary; vice-president, L. E. Drummond, consulting engineer and manager, Mountain Park Coal Co., Edmonton; registrar and secretary, R. S. L. Wilson, professor of civil and municipal engineering, University of Alberta, Edmonton. Councillors were elected as follows: S. G. Porter, superintendent of operation and maintenance, Department of Natural Resources, Canadian Pacific Railway Co., Lethbridge; R. J. Gibb, acting city engineer of Edmonton; R. A. Brown, city electrical engineer of Calgary; R. B. Baxter, engineer and plant superintendent, Alberta Government Telephones, Edmonton; W. G. Gray, chief engineer of power plant, Medicine Hat; F. W. Hobson, chief engineer, Steam Boilers Branch, Alberta Government Department of Public Works, Edmonton; O. E. S. Whiteside, manager, International Coal & Coke Co., Coleman; N. C. Pitcher, professor of mining engineering, University of Alberta.

PERSONAL NOTES

FRANK H. CAVEN has been appointed director of public works of Philadelphia, Pa.

R. W. BERRY, of the United States Geological Survey, has completed the mapping of the Seven Devils Canyon of the Snake River and transferred his party to Ellensburg, Wash., to resume the work of mapping the Trinidad quadrangle.

J. V. NEUBERT, since 1909 engineer of track of the New York Central R.R. Lines east of Buffalo, exterior zone, has been appointed engineer, maintenance of way, of that region, with headquarters at New York City, succeeding G. W. Vaughan, deceased.

U. STEPHENS, formerly city engineer of Waco, Tex., and more recently assistant to the bridge engineer of the Texas State Highway Department, has been appointed resident bridge engineer for Runnels County, Tex., and now is in charge of the construction of a reinforced-concrete and steel-span bridge across the Colorado River near Ballinger, Tex.

T. A. RUSSELL, of Toronto, has resigned as a member of the commission to investigate and report on the Ontario hydro-radial system, and is succeeded by General C. H. Mitchell, dean of the Faculty of Applied Science, University of Toronto.

RALPH CURETON, recently civil engineer with the Southern Power Co. in North Carolina, is now engaged in private engineering business in Greenville, S. C.

WILLIAM F. STROUSE, assistant chief engineer, has been made chief engineer, of the Public Service Commission of Maryland. He succeeds the late Charles G. Edwards. From 1887 to 1903 Mr. Strouse was employed on the preparation of plans and estimates on the Pennsylvania and Baltimore & Ohio railroads, and from the close of that period until 1909 he was assistant engineer of the Washington Terminal Co., in charge of construction of the Washington terminal improvements. From 1909 to 1918 he was assistant engineer with the Baltimore & Ohio Railroad Co. in charge of con-

struction work between Philadelphia and Cumberland, and during the war was supervising engineer, Quartermaster Department, Fort Howard, Md.

PROF. S. C. SHIPLEY, who has been in charge of the mechanical engineering shops at the University of Minnesota, Minneapolis, has resigned to take a similar position in Roberts College, Constantinople. Prof. Shipley and his family will sail for Turkey, from New York, Aug. 14. His acceptance of the European position closes an association of thirteen years with the College of Engineering of the University of Minnesota.

XAVIER A. KRAMER has resigned as state engineer of Mississippi.

DEAN G. EDWARDS has been appointed by the Transit Construction Commission of New York City to be director of construction on the defaulted subway contract of the Intercontinental Construction, covering about 1¼ mi. of line in Brooklyn. The work will be completed by the city on a force account basis. Mr. Edwards had been chief engineer for the contractor on this contract.

LT.-COL EARL B. MORDEN has resigned as chief of the Bureau of Street Cleaning of Philadelphia, after filling that office for three months.

BRIG.-GEN. FRANK T. HINES, chief of the Bureau of Transportation, War Department, has been made head of the Inland and Coastwise Waterways Service, which has been established, under the new Transportation Act, to assist in the development of inland water routes and lines.

JOHN H. NEESON, principal assistant to Fred C. Dunlap, chief of the Bureau of Highways, Philadelphia, has been made acting head of the city's Bureau of Street Cleaning owing to the resignation of Lt.-Col. Earl B. Morden.

F. H. JOYNER, formerly with the Massachusetts State Highway Commission and recently in charge of road construction as county road commissioner for Los Angeles County, Cal., has resigned and will hereafter act as consulting engineer for the Willite Paving Co. and other corporations in Los Angeles. G. W. Jones, of the county road commissioner's office, has been temporarily appointed to succeed Mr. Joyner.

R. J. MCLELLAND has resigned as city engineer of Kingston, Ont., after eighteen years' service.

O. M. LELAND, of the J. G. White Engineering Corporation, New York City, has been appointed dean of the College of Engineering and Architecture and the School of Chemistry of the University of Minnesota. He succeeds Prof. Lauder W. Jones, who resigned to go to Princeton University. Col. Leland was born in Michigan and graduated from the University of Michigan in 1900. During the Spanish War, in 1898 and 1899, he was chief clerk and draftsman to the United States Surveyor-General in Florida. He was aid and computer in the United States Coast and Geodetic Survey in the United States, Alaska and Porto Rico from 1900 to 1903, at the close of which period he became a member of the faculty of the College of Civil Engineering at Cornell University, a position which he held from 1903 to 1920, having charge of the department of topographic and geodetic engineering. During the present year he has acted as engineering supervisor with the J. G. White Engineering Corporation. From 1904 until 1911, Col. Leland had charge of the demarcation of various portions of the boundary between Alaska and Canada, resulting from the arbitration between the United States and Great Britain, and from 1911 to 1913 served as a member of the commission of engineers in the arbitration of the boundary dispute between the Republics of Panama and Costa Rica, having been appointed to that position by Chief Justice White of the United States Supreme Court. During the recent war he was lieutenant-colonel of engineers, serving with the 303rd Engineers, 78th Division, in the St. Mihiel and Meuse-Argonne offensives in France, and later with the 314th Engineers, 89th Division, with the Army of Occupation in Germany.

OBITUARY

R. B. PIPER, city engineer of Medicine Hat, Alta., died in that city on July 19.

WINFIELD S. CADWALADER, for many years superintendent of streets of Trenton, N. J., died July 17 in that city.

HERBERT WATSON HATTON, consulting engineer of Wilmington, Del., died in that city July 13; he was 38 years old. He was born in Downingtown, Pa., and received his civil engineering education from the International Correspondence Schools of Scranton, Pa. During the early part of his professional career he was with T. C. Hatton as chainman, rodman, transitman and leveler. From 1903 until he took up private consulting practice in 1910, he was in charge of the construction of sewers and sewage-disposal plants at Milford, Del., Hyattsville, Md., Bedford Springs, Mt. Carmel, Pa., and Charleston, W. Va. At Berwick, Pa., he was engineer in charge of constructing a dam, reservoirs, roads, bridges, reinforced-concrete conduit, pipe lines and gate houses. As chief assistant engineer on design and construction, with T. C. Hatton, during 1909 and part of 1910 he waterproofed the reservoir at Owego, N. Y., and was in charge of designs for the drainage system for Atlantic City, N. J., and of the extension of that city's water system. In the past ten years, as consulting engineer, he designed and made extensions to sewer systems, water-works and street pavements in many cities. He also acted as consulting engineer for the Equitable Guarantee & Trust Co. of Wilmington, on the construction of a dam, bridge and flood gates at Silver Lake, Milford, and on the appraisal of the Georgetown (Del.) Water Co. plant.

BUSINESS NOTES

R. C. TRIG, formerly with the Berger Manufacturing Co., Canton, Ohio, is now chief engineer of the sales promotion department, National Pressed Steel Co., Massillon, Ohio.

JOSEPH S. STULL, JR., formerly general superintendent of Pusey & Jones Co., Gloucester, N. J., has been appointed assistant manager of ship construction, shipyards and drydocks of the United States Shipping Board.

THE PARSONS CO., manufacturer of trench excavating machinery, Newton, Iowa, has opened a branch office in the Lumber Exchange Building, Chicago, Ill. Its Chicago territory includes the States of Michigan, Illinois, Indiana and Ohio and the eastern section of Missouri. The new office is in charge of James McElroy, central district sales manager.

THE F. C. AUSTIN MACHINERY CO., INC., Chicago, in addition to the Linderman Steel & Machine Co., the F. C. Austin Drainage Excavator Co. and the Municipal Engineering & Contracting Co., has included in the consolidation announced in these columns April 15, p. 794, the Toledo Bridge & Crane Co. Hereafter the organization will be known as the Austin Machinery Corporation.

Pump Testing Plant Completed at Anderson, Ind.

A plant with all facilities for testing centrifugal pumps up to 48-in. size and also for testing the various types of reciprocating pumps made by the Hill Pump Division of the Mid-West Engine Co. has recently been completed at Anderson, Ind. Capacities up to 25,000 gal. per minute or 36,000,000 gal. in 24 hr. can be handled. Beneath the testing laboratory are three concrete tanks with calibrated weirs and a deep sump, the latter being used to test deep well and sump pumps. Provision is also made for checking each test by a Venturi meter and manometer. Motors of various sizes for different speeds and currents are at hand and also steam turbines with torsional dynamometers. Various other accessories are provided. About 5,000 sq.ft. of floor space is available in the testing room and there are facilities for handling five units simultaneously.